RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

PUBLISHED BY THE RADIOLOGICAL SOCIETY OF NORTH AMERICA

VOL. 31 SEPTEMBER, 1938 NO. 3

ROENTGEN VISUALIZATION OF PULMONARY ARTERIAL CIRCULATION IN AUTOPSY MATERIAL[1]

By C. C. BIRKELO, M.D., *and* W. L. BROSIUS, M.D., Herman Kiefer Hospital, *Detroit, Michigan*

INTRODUCTION

PHYSIOLOGICAL efficiency of respiration depends on an efficient pulmonary arterial blood supply. In a respiratory system in which all other factors may be assumed to be normal, the efficiency of respiration is directly proportionate to the efficiency of the pulmonary arterial circulation. So, it becomes of paramount importance to know how disease and the collapse measures employed in the therapeutic management of tuberculosis affect the circulation. Descriptions of the pulmonary circulation in diseased and in collapsed lungs are based largely on the gross and microscopic tissue changes observed at postmortem and, occasionally, in tissue removed surgically. Differentiation by observation between the finer branches of the pulmonary and bronchial arteries is often difficult or impossible. Roentgenography of lungs in which the pulmonary arterial circulation has been injected with radiopaque material offers a method of visualization of vascular alterations.

METHOD

The thoracic contents were removed from the body *en masse*. When pleural adhesions were present, the parietal pleura was also removed and, in cases in which obliterative pleuritis or pneumothorax were present, the parietal pleura was removed intact, preserving the same degree of lung collapse that was present before death as shown in antemortem roentgenograms. The pulmonary artery was severed at the pulmonary ring and the heart and aorta dissected free from the lung. Clotted blood in the right and left pulmonary arteries was removed by gentle traction. Radiopaque material was injected into the pulmonary artery. Injection into the pulmonary artery insures an equal pressure of injection in each lung and in all parts of each lung. An apparatus was devised by which the pressures of inflation and injection were under constant manometric control. Roentgenograms were made of the inflated lungs before and after injection. The lungs were then deflated and with the same apparatus were expanded to their former volume with Kaiserling I. as a fixing solution and were then immersed in fixing solution. After fixation, the lungs were sectioned, leaving slabs measuring from 10 to 15 mm. in thickness, attached to the major bronchi. Tissue for microscopic section was taken and roentgenograms were made of the slabs, permitting a study of finer detail not possible in roentgenograms of the entire lungs. The lungs and the postmortem roentgenograms

[1] Presented before the Fifth International Congress of Radiology, at Chicago, Sept. 13–17, 1937. Publication assisted by grant from the National Tuberculosis Association.

were correlated with the antemortem roentgenograms.

DESCRIPTION OF MATERIAL STUDIED

By the methods described, 170 lungs have been studied. This material has been divided into groups:

Pulmonary Tuberculosis, Untreated, including (1) first infection tuberculosis with relatively recent primary lesions and with fibrosed and calcified primary lesions; (2) re-infection tuberculosis of exudative and productive types with varying degrees of fibrosis, consolidation, and cavitation; (3) miliary tuberculosis and submiliary tuberculosis of apparently hematogenous distribution.

Pulmonary Tuberculosis Treated by Collapse Measures, including (1) artificial pneumothorax, (2) phrenic paralysis, and (3) thoracoplasty.

Complications of Pulmonary Tuberculosis, including (1) pleural effusions, (2) spontaneous pneumothorax, (3) pulmonary hemorrhage, and (4) silicosis with tuberculosis.

Non-tuberculous Diseases, including (1) primary and metastatic pulmonary malignancies; (2) pneumonia of bronchial, lobular, and lobar types in varying stages of consolidation and resolution; (3) postpneumonic and embolic lung abscesses; (4) experimental embolic lung abscesses in dogs, and (5) multiple septic embolic foci.

DISCUSSION

Normal Lung.—In the normal lung, there is uniform filling of the major trunks, the arterioles, and the first portion of the capillary bed; the degree of filling depending on the pressure employed and the duration of the maintained pressure. In a very few instances, wedge-shaped areas failed to inject and in these lungs postmortem thrombi were demonstrable in arterial branches. Nearly all postmortem thrombi were sufficiently contracted to permit the injection mass to pass the thrombi with complete filling of the arterial tree beyond the thrombi.

Tuberculosis—First Infection.—Small primary foci show a narrow zone of diminished circulation surrounding them.

Tuberculosis—Re-infection, Exudative.—In the acute exudative type of tuberculosis, there is usually little demonstrable alteration in the arterial circulation if the lesions are discrete and not very large. In the larger areas of consolidation where tissue destruction takes place and small cavities are formed, there is a demonstrable diminution in size of the larger vessels and a lack of the fine branches normally present in the arterial tree. In areas of tuberculous pneumonia, the fine branches are almost completely obliterated and the large trunks are markedly reduced in size. Vessels of medium size often appear to end abruptly. The degree of such change is in direct proportion to the amount of tissue destruction. We have, also, injected thread-like vessels in trabeculæ crossing large cavities. These are the remnants of vessels which were formerly of large size and represent the last vestiges of pulmonary arterial circulation in these areas. In a patient who died of hemorrhage, the injection mass filled one of several cavities, indicating the area in which the hemorrhage took place.

We studied a specimen from a patient who had had small hemorrhages for the past twenty years of his life but he did not die from hemorrhages. He had a very insignificant appearing apical tuberculous lesion with a small excavation which was probably the source of his hemorrhages. This cavity did not fill with the injection mass as there had been no recent bleeding. A pulmonary aneurysm had been considered but was ruled out by the injection.

Tuberculosis—Re-infection, Productive.—Our material includes cases showing varying degrees of healing of tuberculous lesions. We have antemortem film records of these cases showing development of the lesions and progress of healing. In two of the cases, large cavities were seen to diminish in size and be eventually replaced by shadows that were interpreted as fibrous bands. In many areas of extensive

involvement, progressive clearing resulted in apparently well aerated areas of apparently useful lung with fibrous strands and occasional small deposits of calcium. In some of these cases, cavities persisted on one side and, when collapse measures were instituted placing the burden of the respiratory function on portions of the lung which show roentgenographic evidence of scarring by tuberculous infection, these patients became markedly dyspneic. In such areas of scarring, our injections have demonstrated a striking diminution in pulmonary arterial circulation with consequent diminution in respiratory function. This accounts for the dyspnea which patients develop when the burden of respiration is placed on such scarred lung tissue. These findings have been so constant that we believe it is possible to estimate respiratory efficiency of such lungs from the amount of scarring visualized in roentgenograms.

Proper evaluation of roentgenographic evidence of scarring will serve as a warning against the use of collapse measures in patients who show relatively large areas of lung tissue which, although appearing well aerated, have the fibrous bands and calcium deposits which indicate former extensive tuberculous involvement.

Tuberculosis—Miliary.—In miliary tuberculosis, vascular changes are not demonstrated by the method used. The lesions are small and discrete and death takes place before the lesions coalesce and produce areas of vascular diminution large enough to be visualized by roentgenography.

Tuberculosis—Collapse Therapy.—The effect of pneumothorax on the circulation is in direct proportion to the degree of collapse. With slight collapse, there is a slight decrease in the amount of injection material in the finest branches injected. With greater reduction of lung volume, the larger trunks are seen to be tortuous and to lie close to each other but to be well filled with injection mass. When the collapse is complete or almost complete, the large trunks and branches show a definite reduction in size. When lungs which have been collapsed are re-expanded, normal vascular filling is found in areas not affected by disease. This seems to be true as long as the lung is capable of re-expansion.

The effect of phrenic surgery on the circulation is slight. In lungs whose volume has been reduced by elevation of the diaphragm, the vascular trunks are seen to be closer together than in lungs with normal expansion and there is normal filling of trunks and branches in all areas free from disease.

Lungs collapsed by thoracoplasty show the same changes as lungs collapsed by pneumothorax. In our material are cases which have been collapsed by thoracoplasty for periods of time ranging from one day to six years.

In collapsed and partially collapsed lung tissue, the areas of tuberculous involvement show circulatory changes similar to those described in expanded lungs. These changes are made more evident by the crowding together of the vascular channels in the collapsed tissue, so that portions of normal lung contain large amounts of injection mass and diseased areas are brought into sharp relief by their diminished amount of injection. In such lungs, it is evident that the changes in circulation produced by collapse are very slight when compared to those produced by disease.

Silicosis and Tuberculosis.—In silicosis, the degree of vascular change depends on the stage of the disease. Lungs which have small discrete nodules show a normal vascular tree. Clinically, these patients are usually not dyspneic and are often unaware of their disease. Where the lesions are larger, with large nodules or coalescence of small nodules, there is a marked decrease in circulation. The large trunks are narrowed to thin lines and fine branches are almost entirely absent. This diminished vascularity is, probably, one of the major factors producing the dyspnea which is such a prominent clinical symptom of advanced silicosis.

A case in which the silicotic areas were

near the lung hilum showed a very marked narrowing of the arterial trunks passing through the silicotic region and markedly diminished vascularity of the apparently well aerated peripheral portion of the lung supplied by these vessels.

Non-tuberculous Pulmonary Disease.—In pneumonia, the circulatory changes observed vary with the stage of the disease. In areas of early consolidation, there is a slight but definitely demonstrable widening of the smallest arteries. This is best demonstrated in peribronchial and lobular consolidations where there is an opportunity for comparison with adjacent normal lung. As consolidation progresses and reaches the stage of gray hepatization, there is a progressive decrease in the amount of injected material in the small vessels but the large trunks are not affected. In a few of our cases of advanced pneumonia, areas of complete avascularity were seen. When sectioned, there were found to be areas of necrosis and abscess formation, probably on the basis of vascular occlusion.

In cases of sepsis showing septic embolic foci in the lungs, avascularity of the infarcted areas was demonstrated. In a specimen with multiple hemorrhagic foci, the injection mass extravasated into the tissues and alveoli in the areas of hemorrhage.

Embolic abscesses were produced in dogs and studied at different age periods. The abscess areas do not receive the injection mass in the acute stage because of the septic plug occluding the artery. During the excavating stage, there is only scant injection about the cavity and, in the final scar, there is a very restricted circulatory supply to this area.

SUMMARY

Roentgenography of the lungs after vascular injection with radiopaque material affords a method of visual demonstration of circulatory alterations in pulmonary disease and in collapse therapy.

At the present stage of our investigation, it seems probable that pulmonary tuberculosis causes a marked decrease in pulmonary arterial circulation in the portion of the lung involved and that this impairment is proportionate to the degree and stage of the tuberculous involvement and that it is permanent. Our work, also, indicates that collapse measures decrease the total volume of pulmonary arterial circulation in proportion to the degree of collapse but the circulation returns to normal when the lung re-expands.

It is hoped that the method described will prove useful in increasing the knowledge of the physiology and pathology of the circulation of the blood.

See plates 1–28 on the following pages.

Case No. 89080. Age, 57 years; male; white.
Acute diphtheritic pharyngitis and laryngitis.

Plate 1. (Case No. 89080, Fig. 1.)
Normal lungs inflated to antemortem volume.

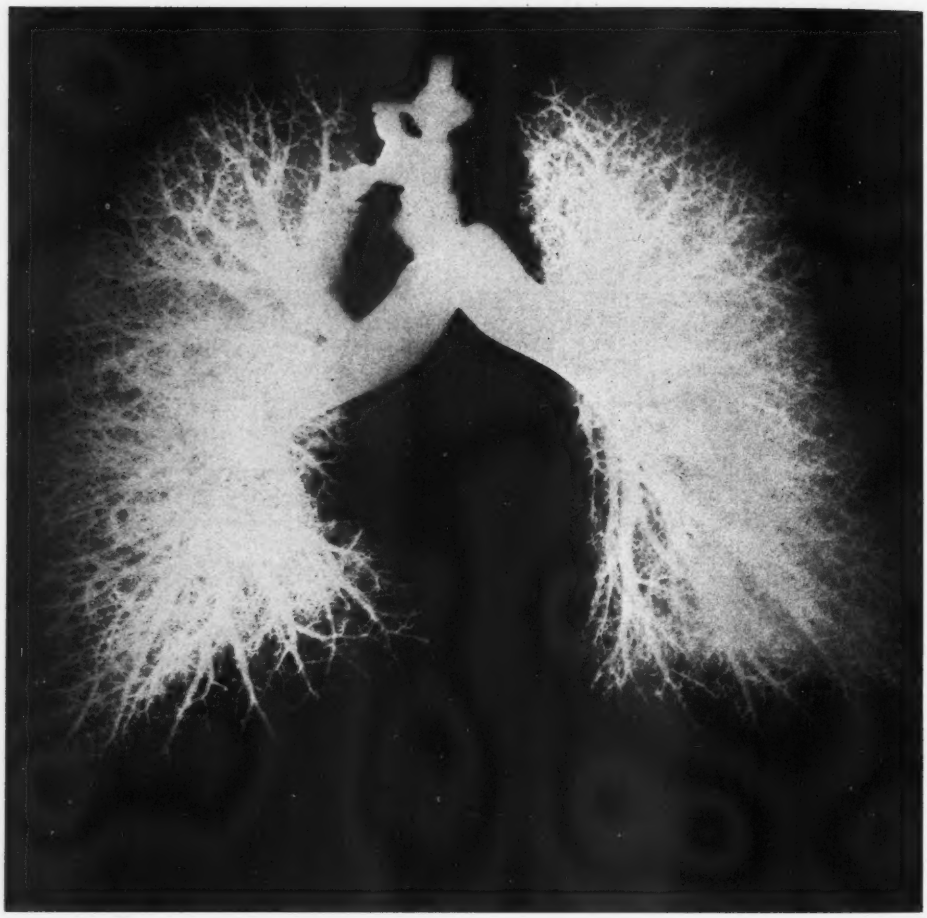


Plate 2. (Case No. 89080, Fig. 2.)
Normal injection of pulmonary arterial circulation.

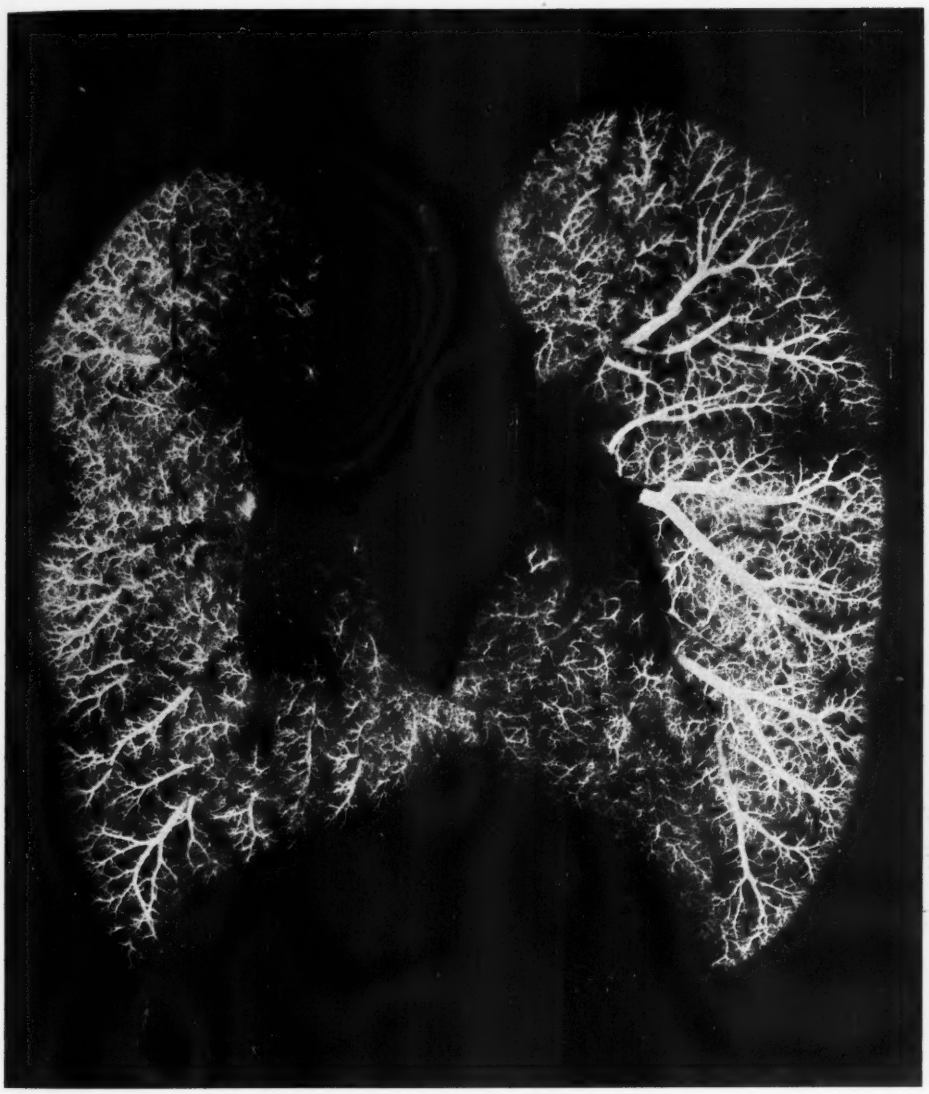


Plate 3. (Case No. 89080, Fig. 3.)
Section from fixed lungs showing normal injection.

Case No. 16713. Age, 49 years; male; white.

Far advanced pulmonary tuberculosis.

The patient entered the hospital six months after the onset of the disease, with far advanced pulmonary tuberculosis. There were large cavities on the right and small cavities on the left. Artificial pneumothorax was attempted on the right but failed to close the cavities, and fluid developed. Artificial pneumothorax was attempted on the left but the patient became dyspneic and a spontaneous pneumothorax occurred on the left. Dyspnea and cyanosis gradually increased to expiration.

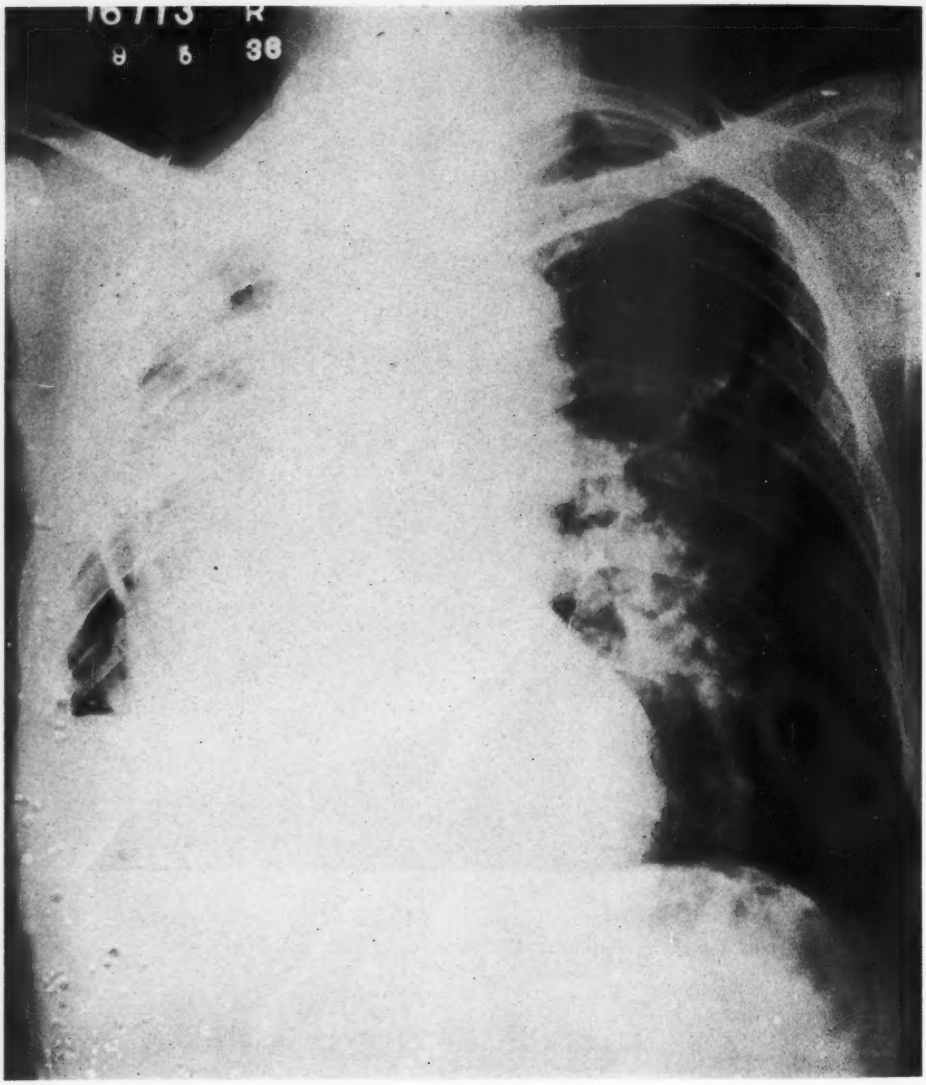


Plate 4. (Case No. 16713, Fig. 1.)

Sept. 5, 1936: Far advanced pulmonary tuberculosis. Artificial pneumothorax on right ineffectual.

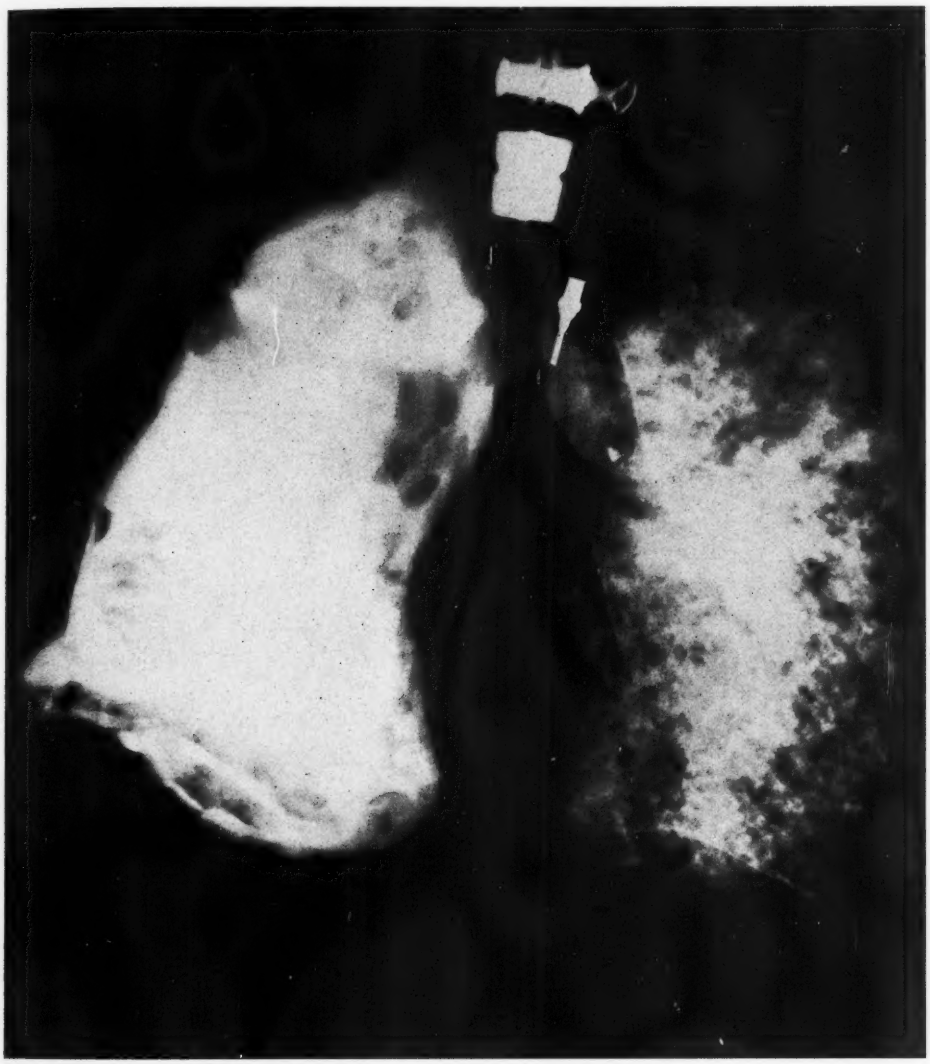


Plate 5. (Case No. 16713, Fig. 2.)

Oct. 17, 1936: Lungs inflated to antemortem volume. Tuberculous consolidation of right lung, with excavation. Recent exudative lesion on left, which has progressed since the roentgenogram made six weeks before death.

Plate 6. (Case No. 16713, Fig. 3.)

Injection of pulmonary arterial circulation shows diminished vascularity, with marked reduction of small branches in areas of tuberculous consolidation.

Plate 7. (Case No. 16713, Fig. 4.)

Section from fixed lungs shows constrictions of the arterial trunks in the middle portion of the right lung. An early stage of obliteration of the large vessels.

Case No. 15889. Age, 31 years; male; white.

Far advanced pulmonary tuberculosis.

The duration of the illness was two months. The onset followed an appendectomy. Gastrointestinal symptoms became increasingly severe and the patient was not benefited by pneumoperitoneum.

At autopsy, massive bilateral exudative pulmonary tuberculosis with bilateral excavations, ulcerative tuberculous laryngitis, ulcerative tuberculous enterocolitis, and generalized tuberculous peritonitis were found.

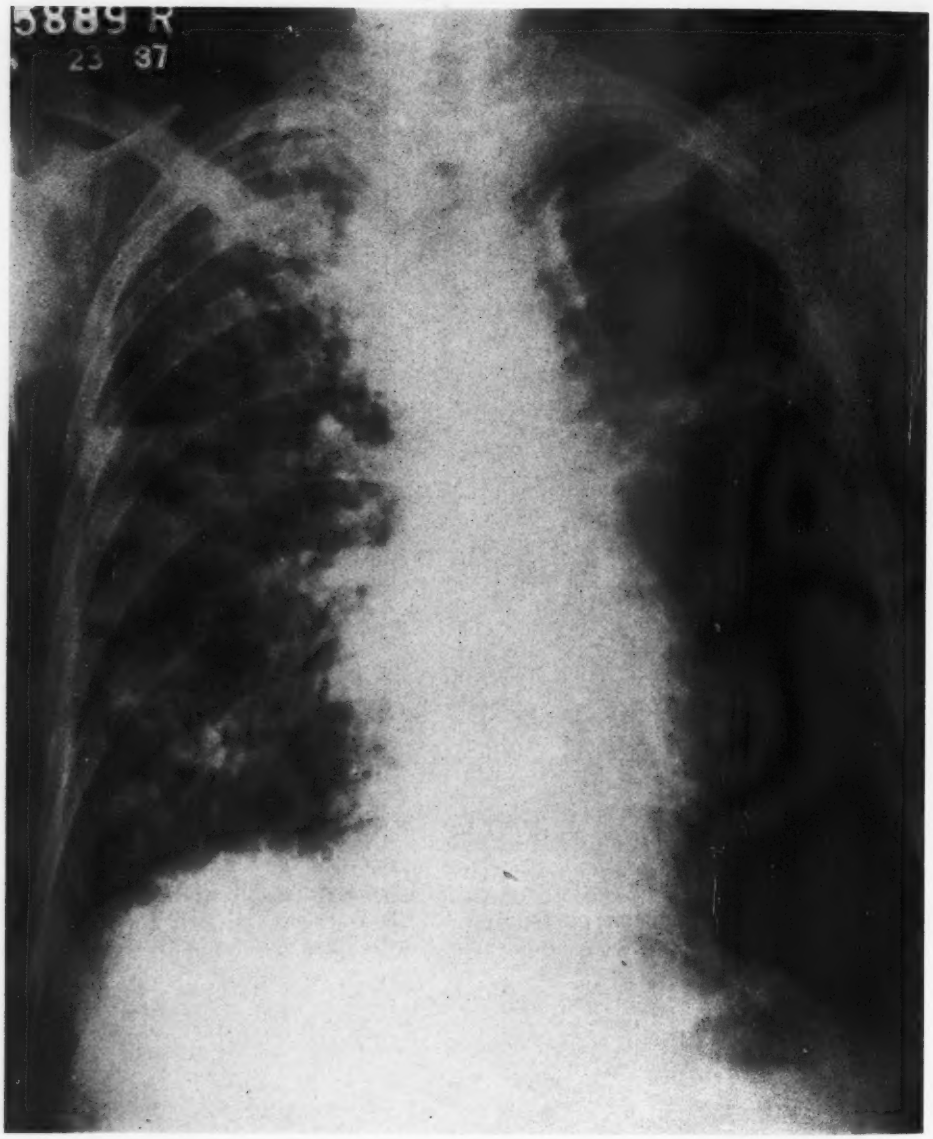


Plate 8. (Case No. 15889, Fig. 1.)

April 23, 1937: Far advanced bilateral pulmonary tuberculosis with large cavities.

Plate 9. (Case No. 15889, Fig. 2.)

May 6, 1937: Lungs inflated to antemortem volume. Consolidation is more extensive than is shown in the roentgenogram made thirteen days before death.

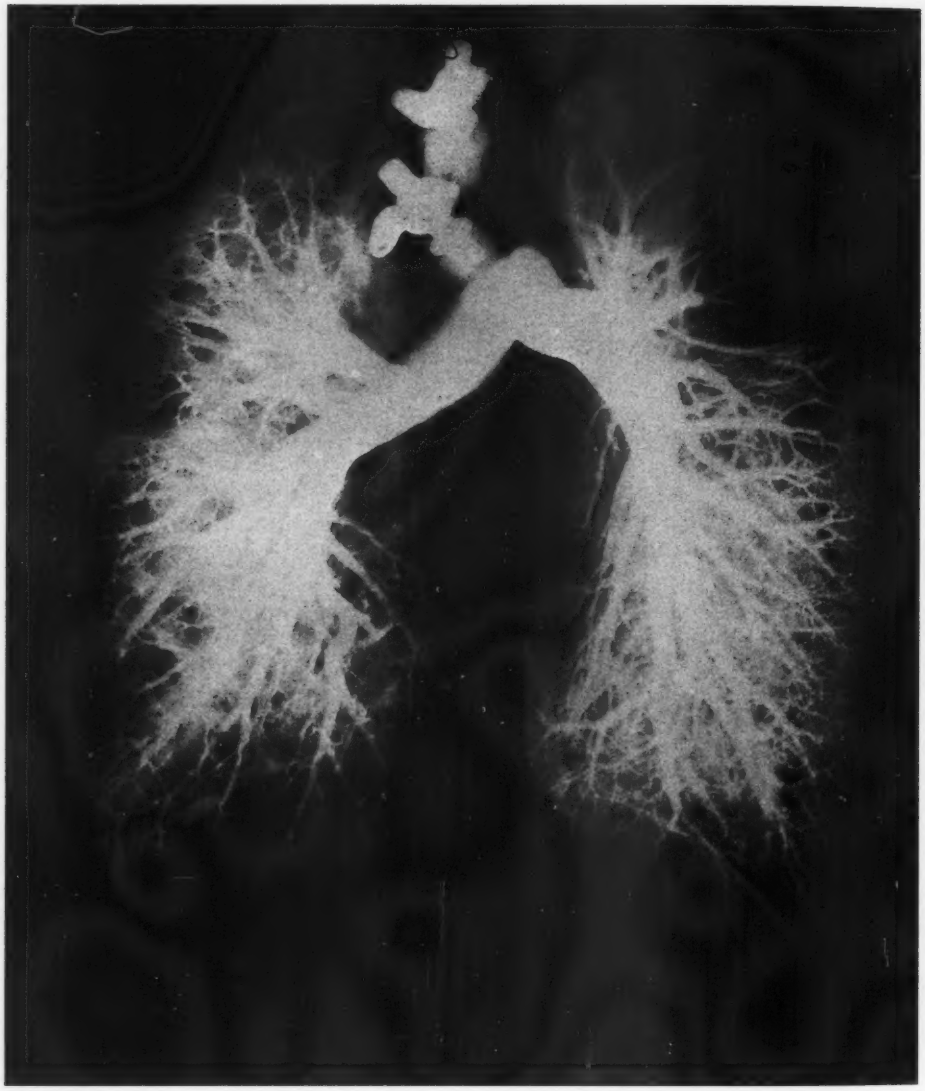


Plate 10. (Case No. 15889, Fig. 3.)

Injection of the pulmonary arterial circulation. On the right, there is a marked decrease in small branches. On the left, narrow vessels in the trabeculations of the cavity are injected.

Plate 11. (Case No. 15889, Fig. 4.)

Section from fixed lungs. On the right, the arterial trunks are markedly narrowed and have few branches.

Case No. 15979. Age, 36 years; female; white.

Far advanced pulmonary tuberculosis.

The duration of the disease, on admission, was two years. There was extensive involvement of the left lung. Artificial pneumothorax on the left produced good collapse except for the apical region where there were large adhesions. The pneumothorax was maintained for four months. She developed a very extensive ulcerative tuberculous enteritis, with severe anemia, and expired.

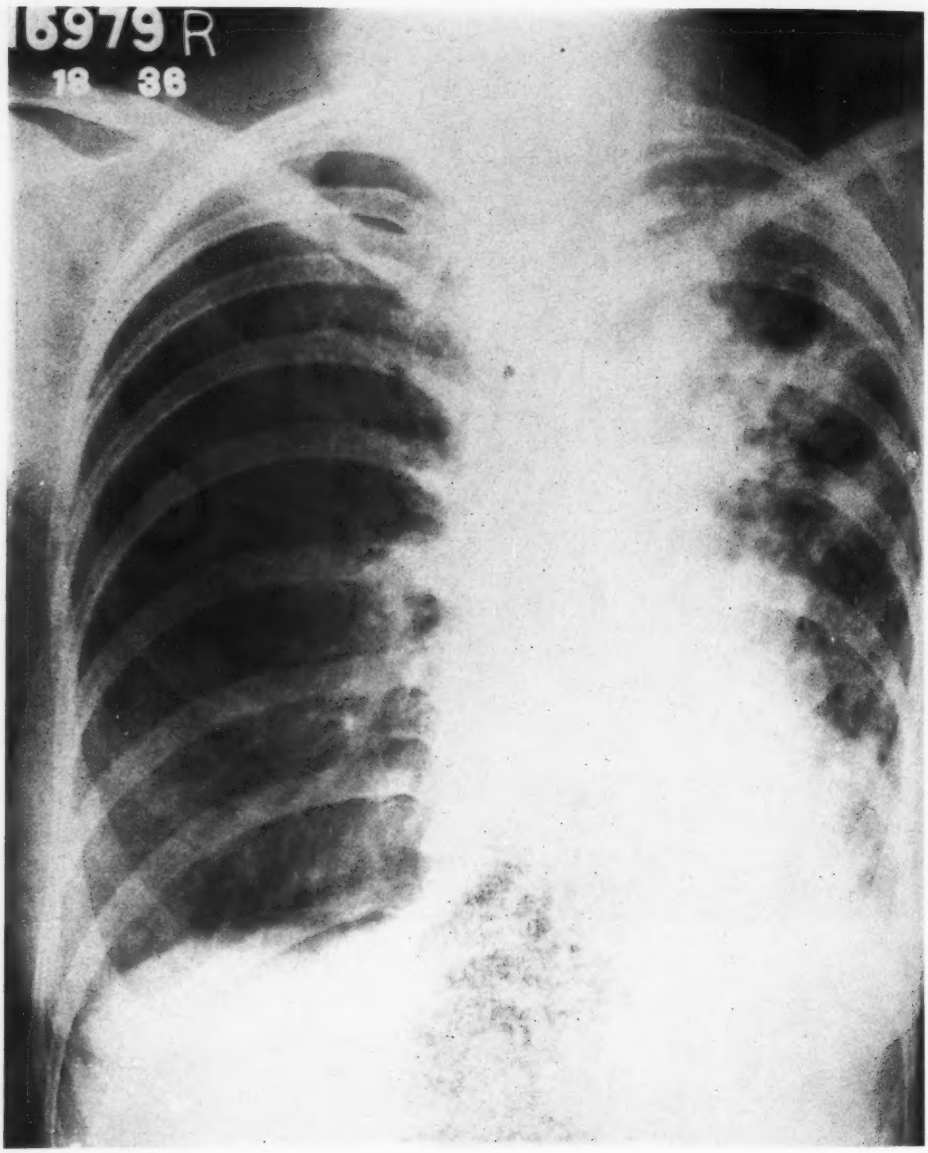


Plate 12. (Case No. 15979, Fig. 1.)

Feb. 18, 1936: There is an area of productive tuberculosis in the right apex and an extensive mixed lesion throughout the left lung, with excavations.

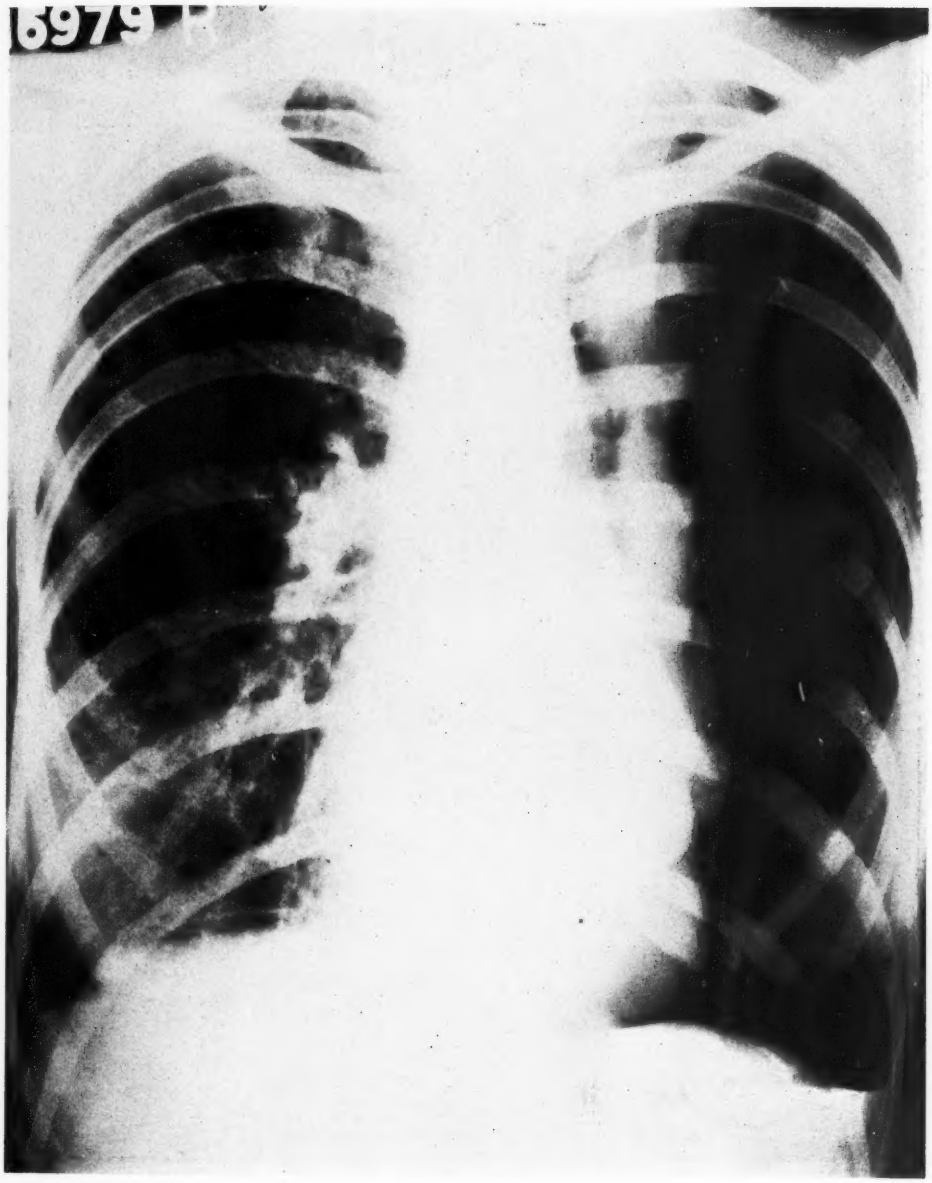


Plate 13. (Case No. 15979, Fig. 2.)
April 30, 1936: Left lung well collapsed by artificial pneumothorax.

Plate 14. (Case No. 15979, Fig. 3.)

June 22, 1936: Lungs inflated to antemortem volume. Collapse of the left lung maintained by thickened pleura. The cavities are not closed. In the right lung, the area of increased density at the apex is a fibrous cap of tuberculous scar tissue.

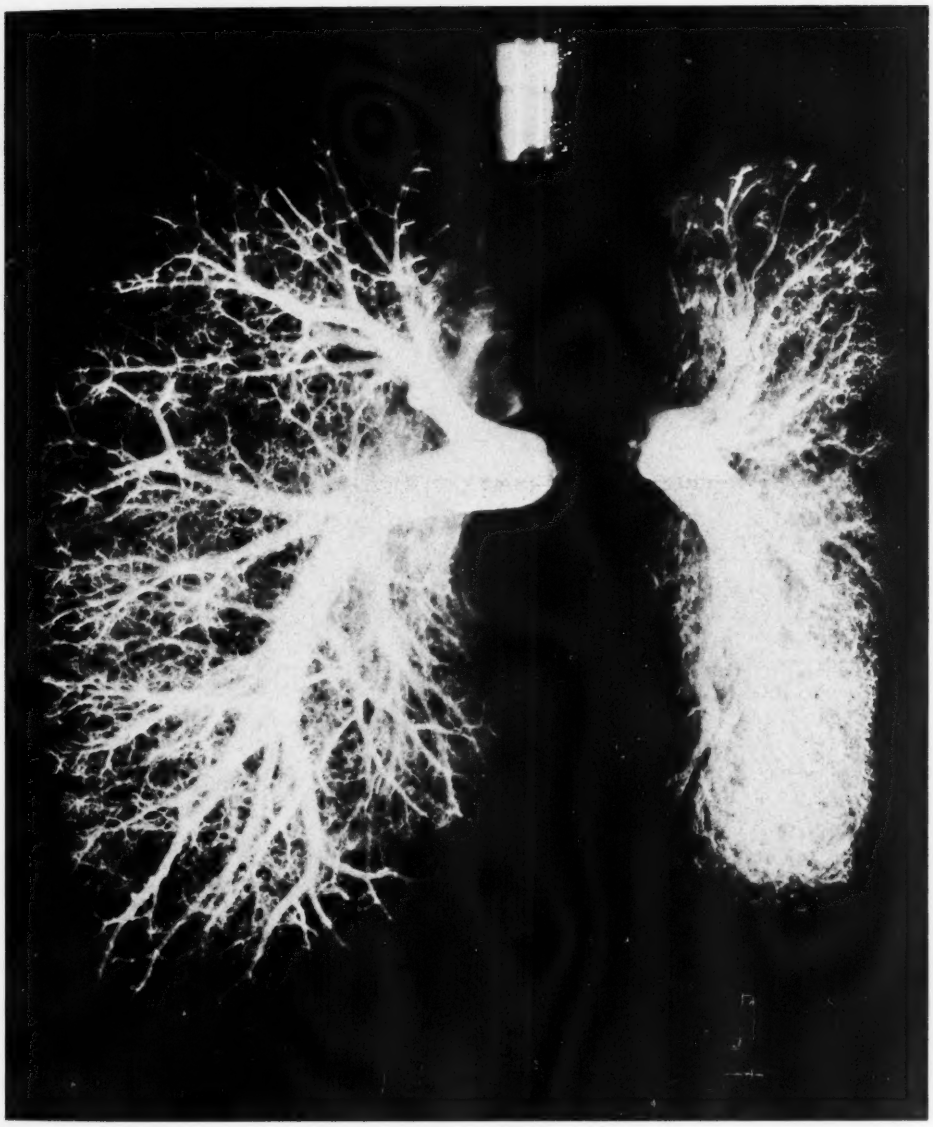


Plate 15. (Case No. 15979, Fig. 4.)

Injection of pulmonary arteries. In the right lung, there is a marked decrease of circulation in the productive area at the apex. In the left lung, the small area of productive tuberculosis at the apex shows a marked decrease in circulation. The vessels in the remaining portion of the left lung are tortuous due to collapse but appear to be well preserved.

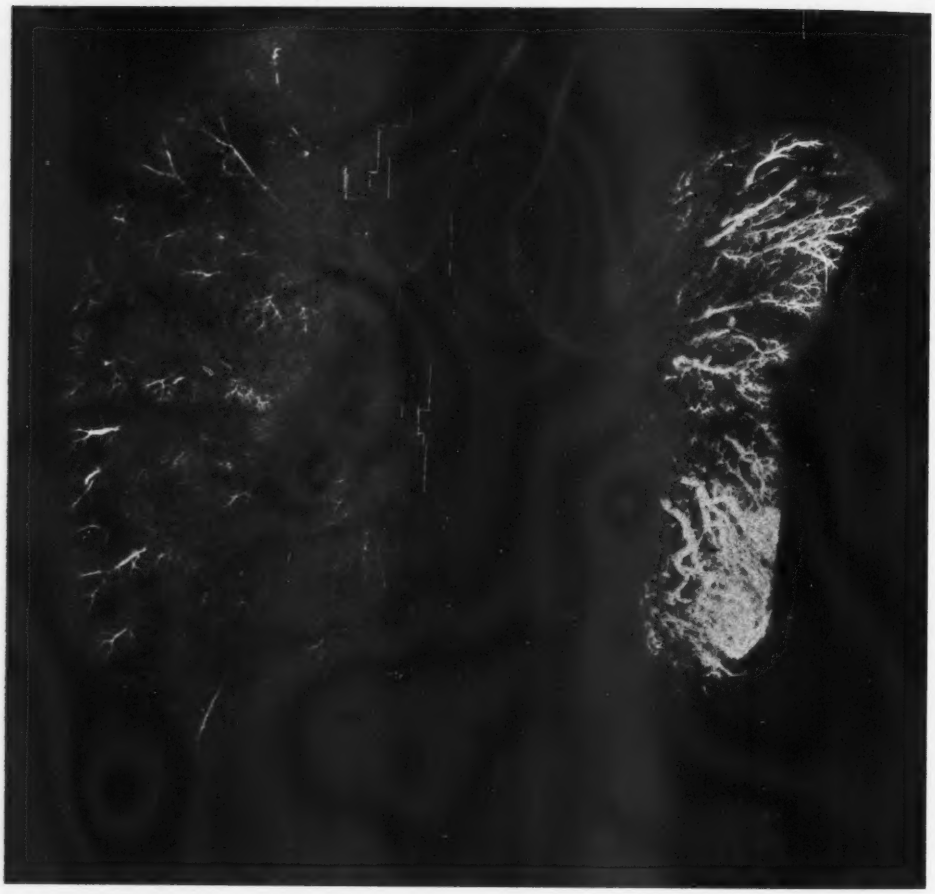


Plate 16. (Case No. 15979, Fig. 5.)

In the right lung, the diminished circulation in the area of the productive tuberculosis in the upper portion of the upper lobe is in sharp contrast to other portions of the lung. In the left apex, where there is productive tuberculosis, there is a very marked decrease in circulation. In other portions of the left lung, the vessels are well injected, including the fine branches, even though the lung was well collapsed by artificial pneumothorax for four months.

Case No. 10559. Age, 26 years; male; white.

Far advanced pulmonary tuberculosis.

The duration of illness before admission was two years. Right artificial pneumothorax was instituted on Aug. 27, 1931, and maintained for one year (to Aug. 18, 1932) when, due to the progressive development of pleural adhesions, the space was lost. Left pneumothorax was instituted on May 7, 1931, and maintained for three years (to May 11, 1934). A left phrenicectomy was done Oct. 15, 1931. The patient left the hospital on a signed release May 15, 1934, and was re-admitted Dec. 24, 1936, markedly dyspneic, and too ill for further therapy. His dyspnea increased to exit (June 23, 1937).

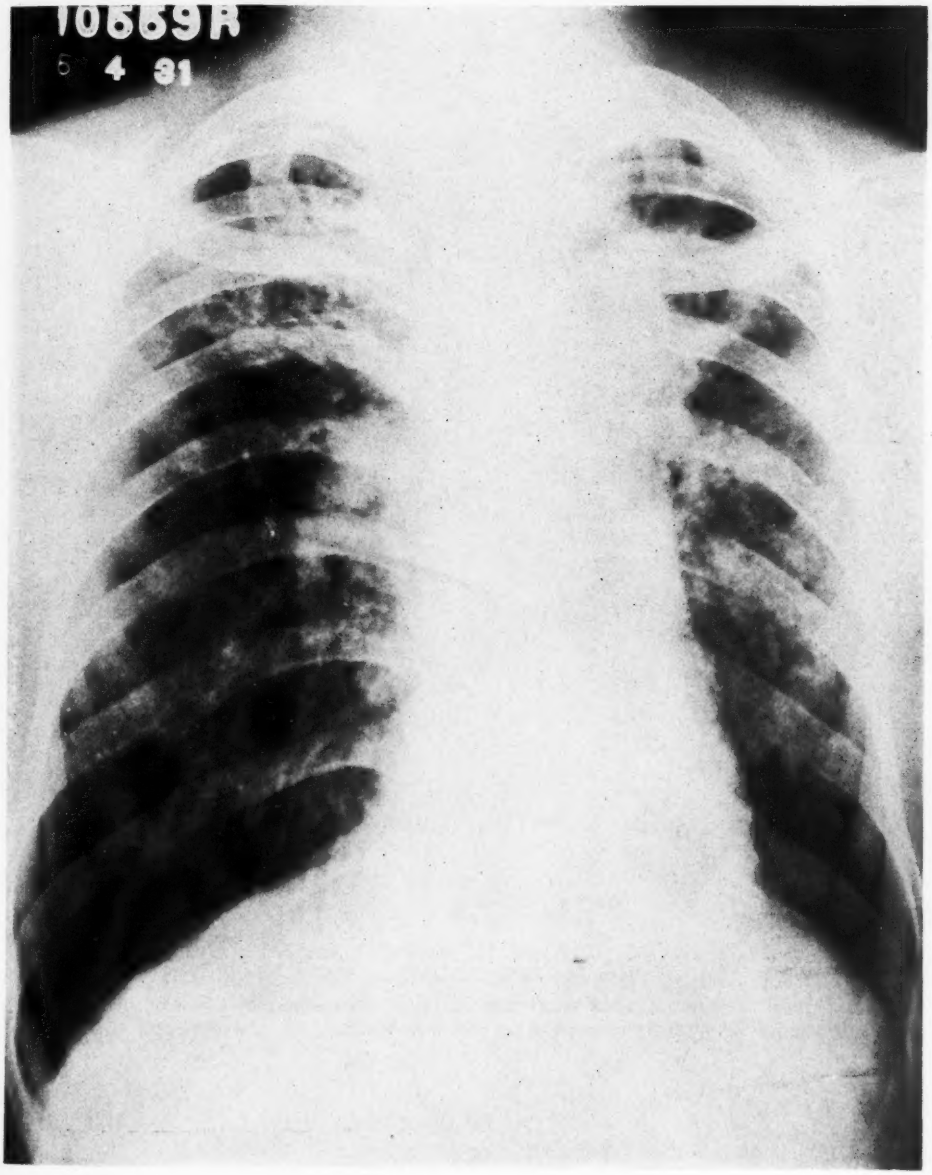


Plate 17. (Case No. 10559, Fig. 1.)

May 14, 1931: Bilateral productive tuberculosis with bilateral cavitation.

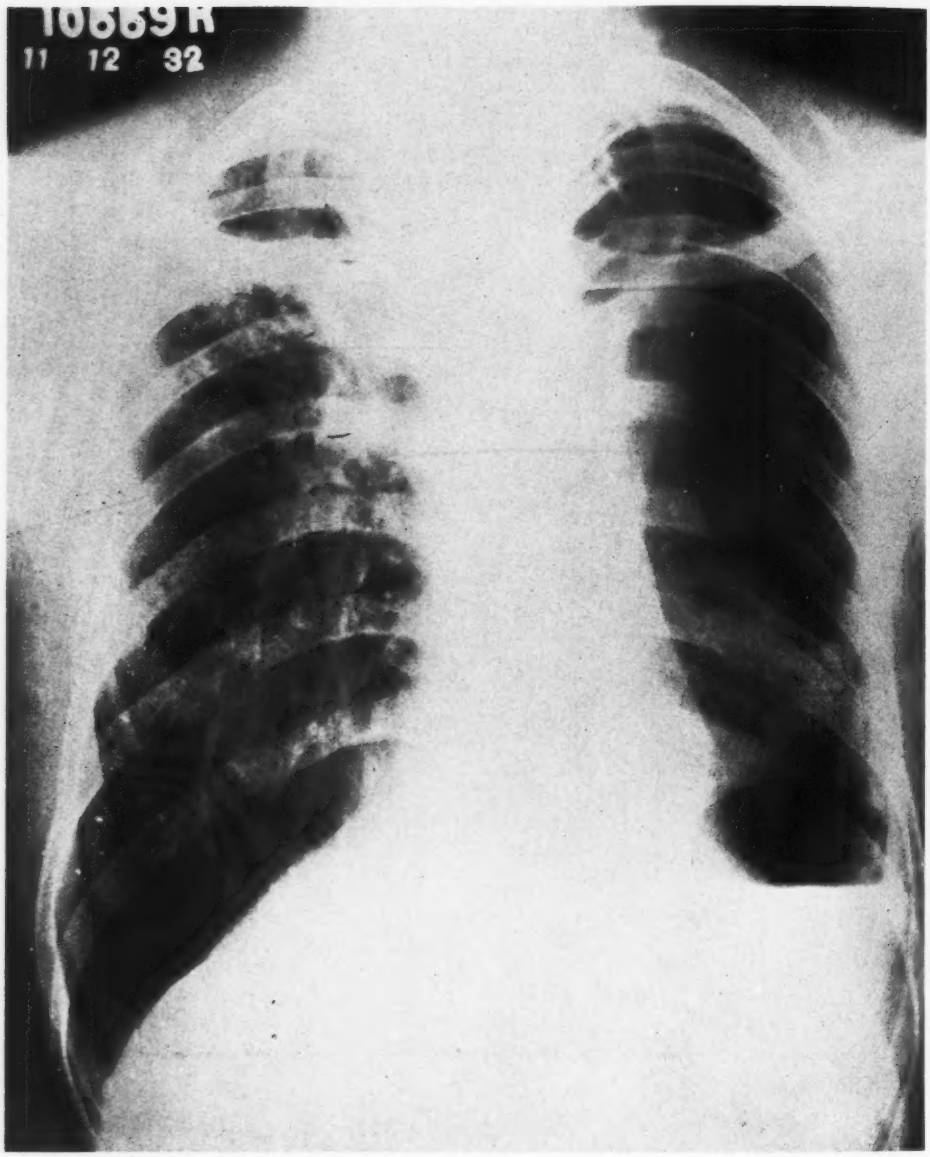


Plate 18. (Case No. 10559, Fig. 2.)

Nov. 12, 1932: Pneumothorax space on the right has been lost. Cavities still open. Cavities on the left apparently controlled by pneumothorax.

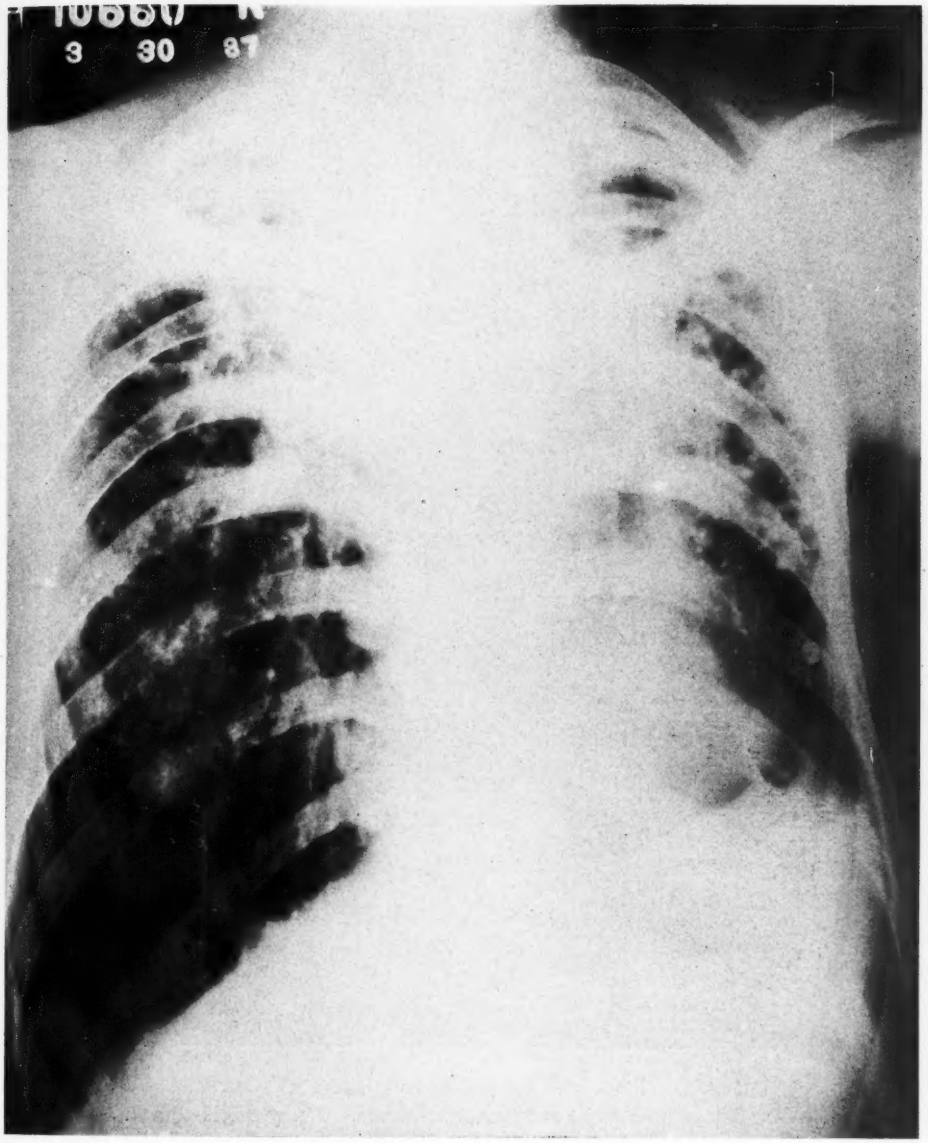


Plate 19. (Case No. 10559, Fig. 3.)

March 30, 1937: Left lung re-expanded. Large bilateral cavities. Extensive fibrosis, with calcified granules throughout both lungs, but remaining portions of lung parenchyma appear to be well aerated.

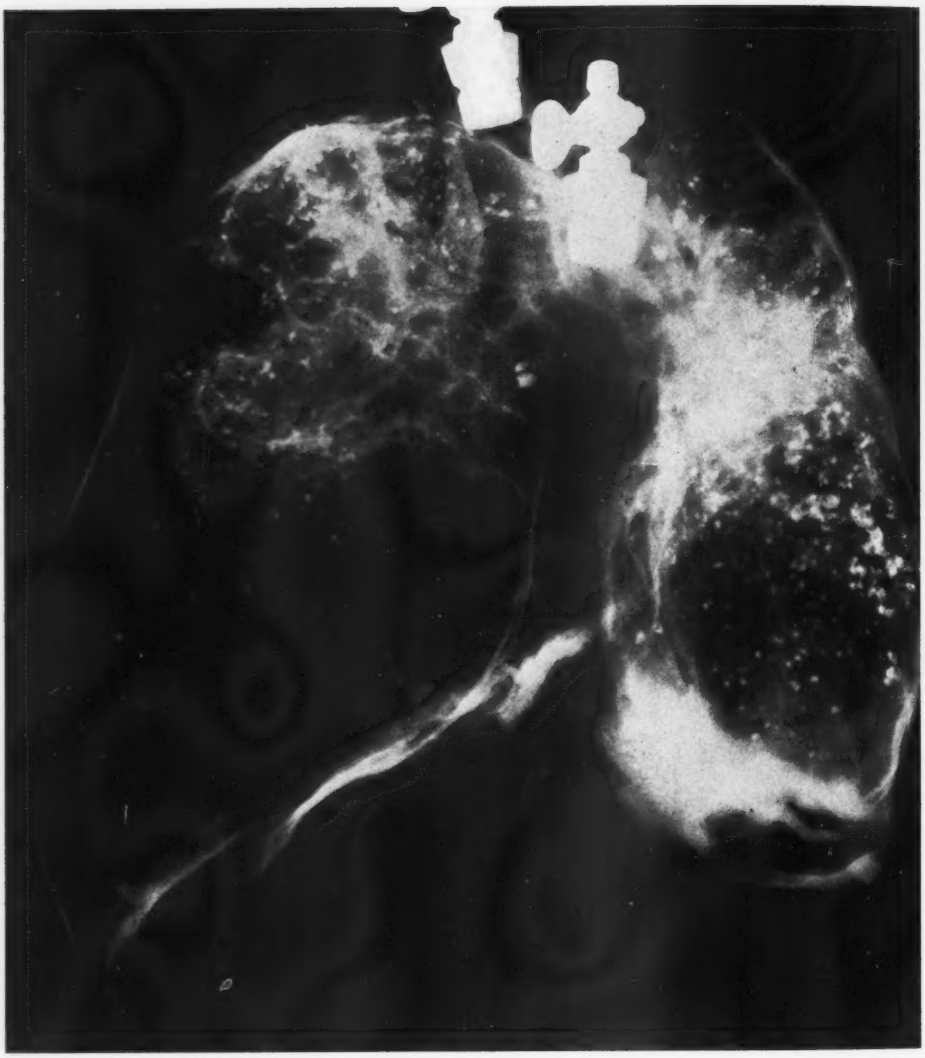


Plate 20. (Case No. 10559, Fig. 4.)

June 23, 1937: Lungs inflated to antemortem volume. Many calcified granules throughout the parenchyma of both lungs.

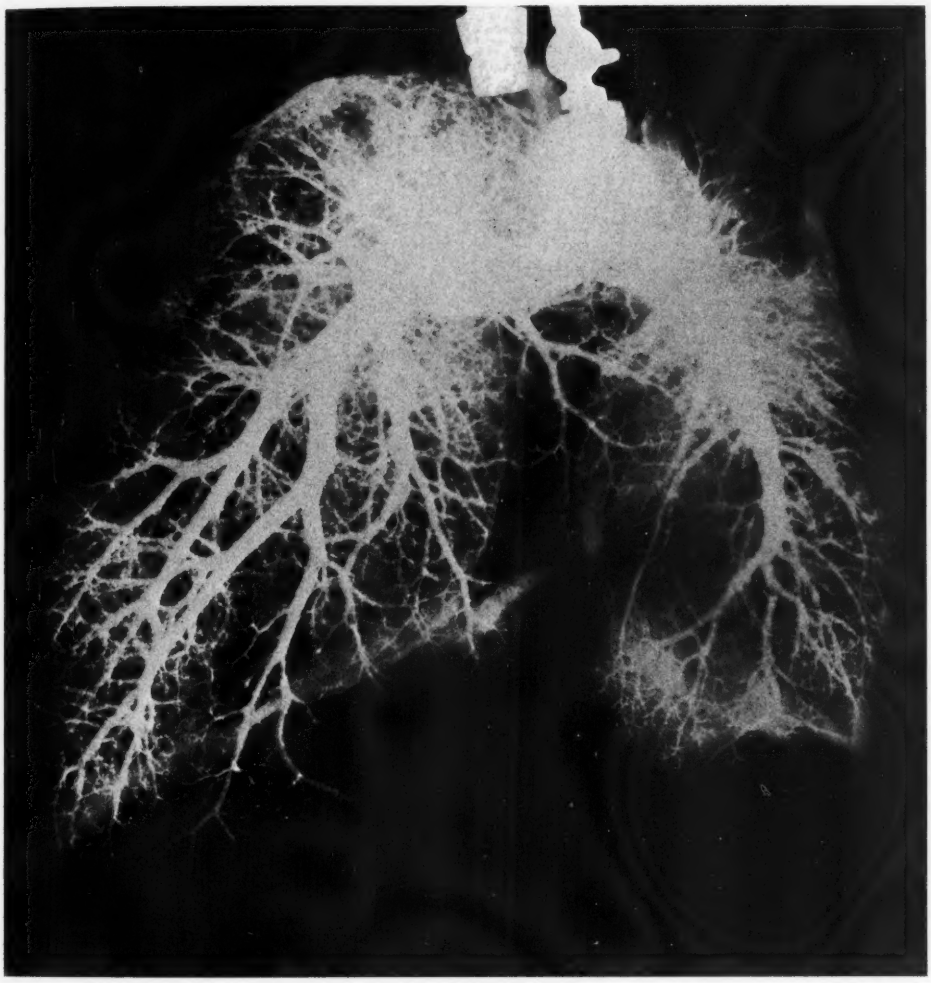


Plate 21. (Case No. 10559, Fig. 5.)

Pulmonary circulation injected. The circulation is diminished in proportion to the amount of scar tissue present.

Plate 22. (Case No. 10559, Fig. 6.)

Section from fixed lungs. The terminal branches of the pulmonary artery are markedly diminished. Their numbers approach normal in only a few scattered areas, chiefly the lower and middle portions of the right lung. The marked decrease in the terminal portion of the circulatory bed accounts for the patient's dyspnea.

Case No. 13351. Age, 29 years; male; colored.

Far advanced pulmonary tuberculosis.

The duration of the illness, on admission, was six months. A left artificial pneumothorax was maintained three and a half years, from Oct. 30, 1933, to April 16, 1937. A right phrenic exeresis was done on Oct. 18, 1934, and repeated on June 25, 1935. Four stages of thoracoplasty, including the first to the ninth ribs, were done on the right side between March 24, 1936, and April 1, 1937. Following his thoracoplasty, dyspnea became extreme and was only partially relieved while in an oxygen tent.

At autopsy, the heart weighed 320 gms. and there was marked hypertrophy of the right auricle and ventricle.

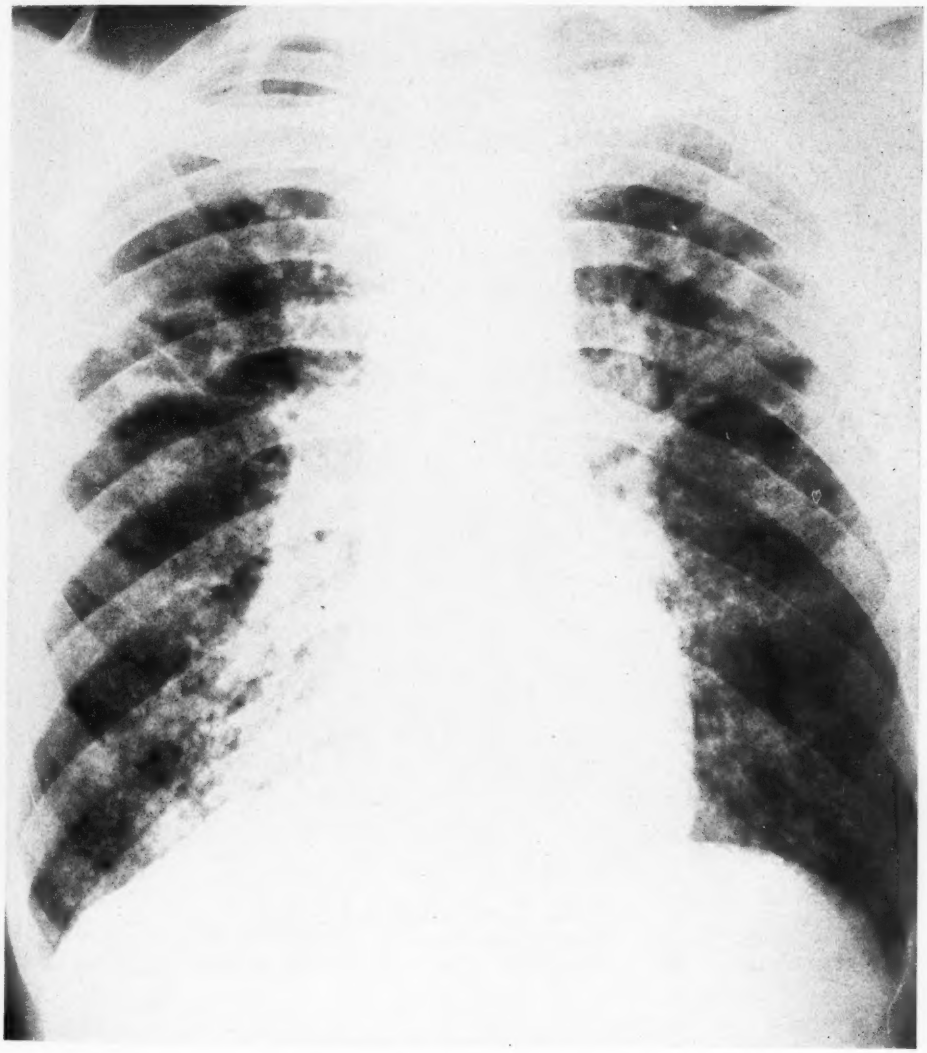


Plate 23. (Case No. 13351, Fig. 1.)

Oct. 21, 1933: Widely distributed small lesions throughout both lungs, with bilateral cavities.

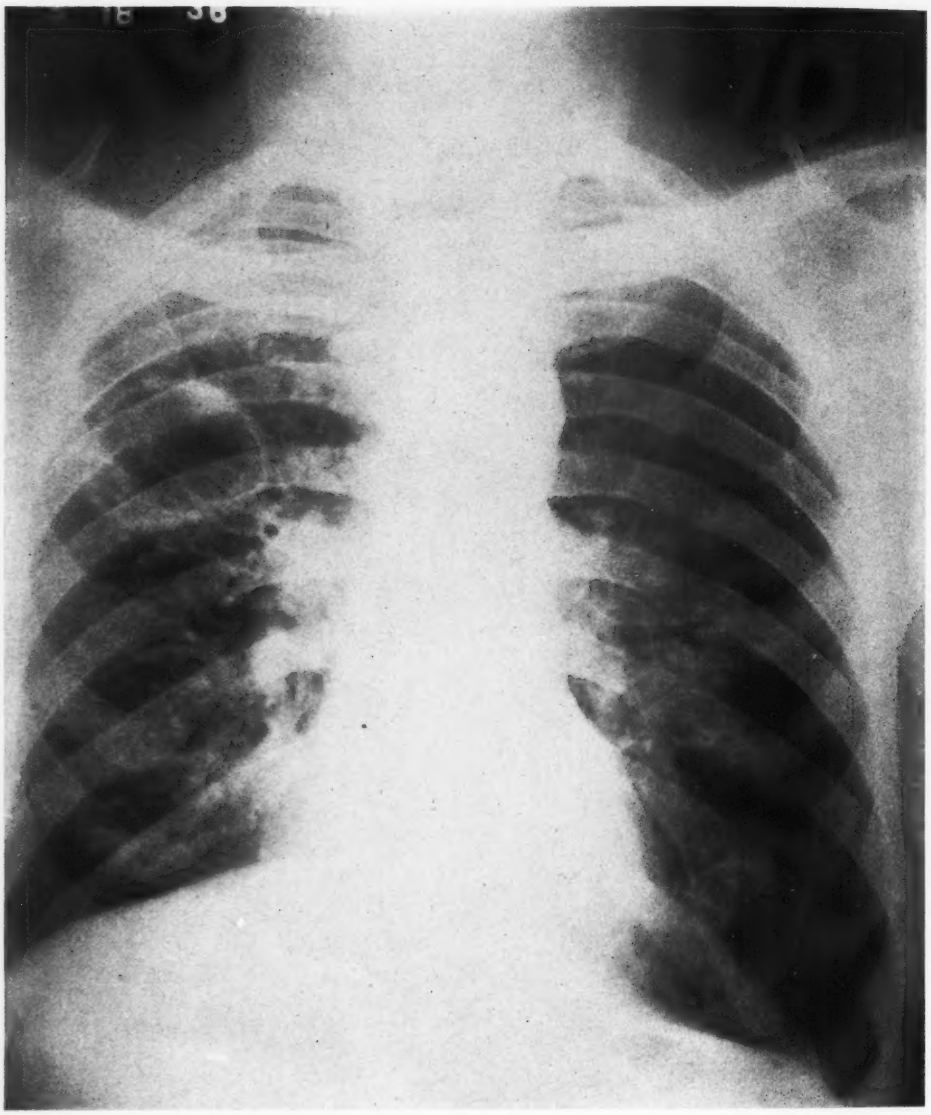


Plate 24. (Case No. 13351, Fig. 2.)

March 18, 1936: Extensive bilateral tuberculosis of productive type, with large cavity on the right. Cavities on the left not visible. Left lung partially collapsed by pneumothorax.

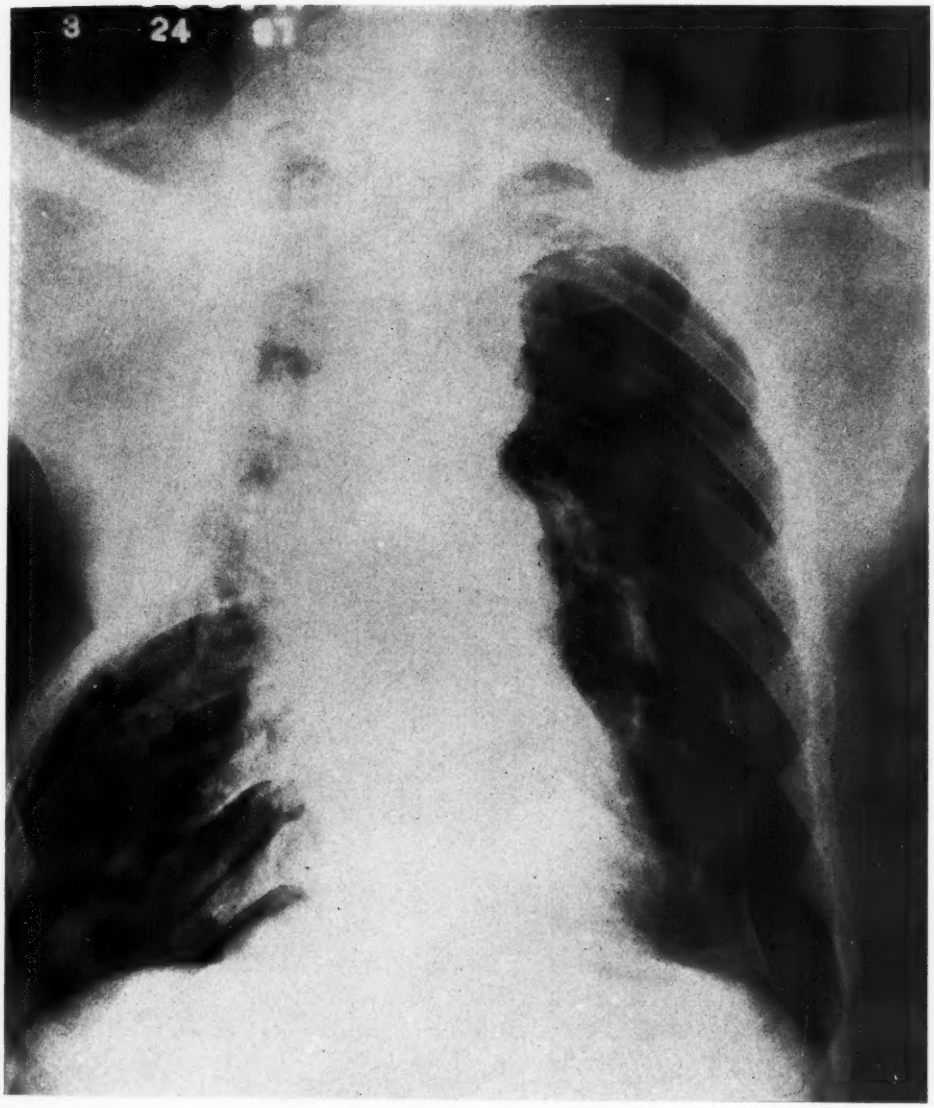


Plate 25. (Case No. 13351, Fig. 3.)

March 24, 1937: Thoracoplasty has reduced the size of the cavity. Patient markedly dyspneic in spite of apparently well aerated lung parenchyma.

Plate 26. (Case No. 13351, Fig. 4.)

May 1, 1937: Lungs expanded to antemortem volume with partial re-expansion of the portion of the right lung which was partially collapsed by thoracoplasty. Exudative lesion in lower right has progressed since roentgenogram, taken five and a half weeks before death. Left lung was permitted to re-expand before death and shows extensive scarring with emphysema in the upper portion. Cavity not visible.

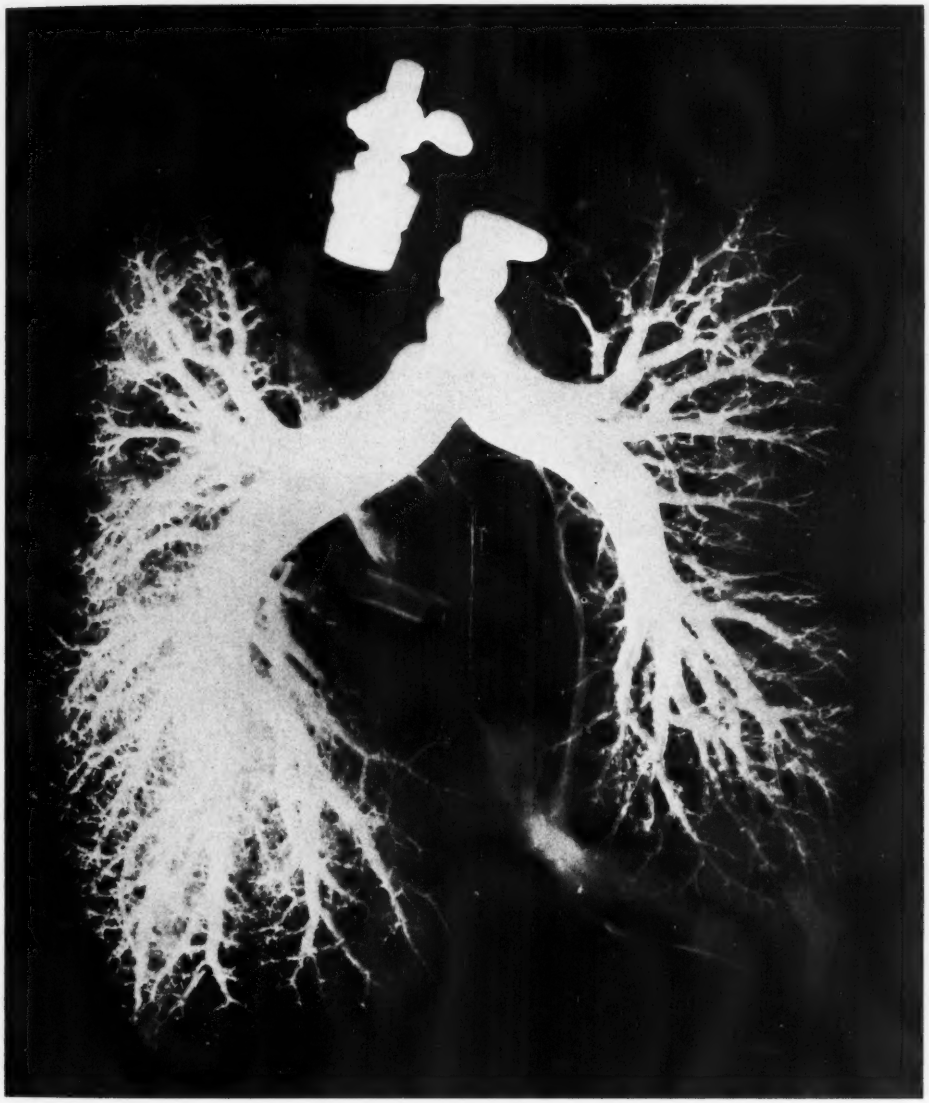


Plate 27. (Case No. 13351, Fig. 5.)

Injection of pulmonary artery. The large trunks are well developed but fine branches are very few, especially in the left lung.

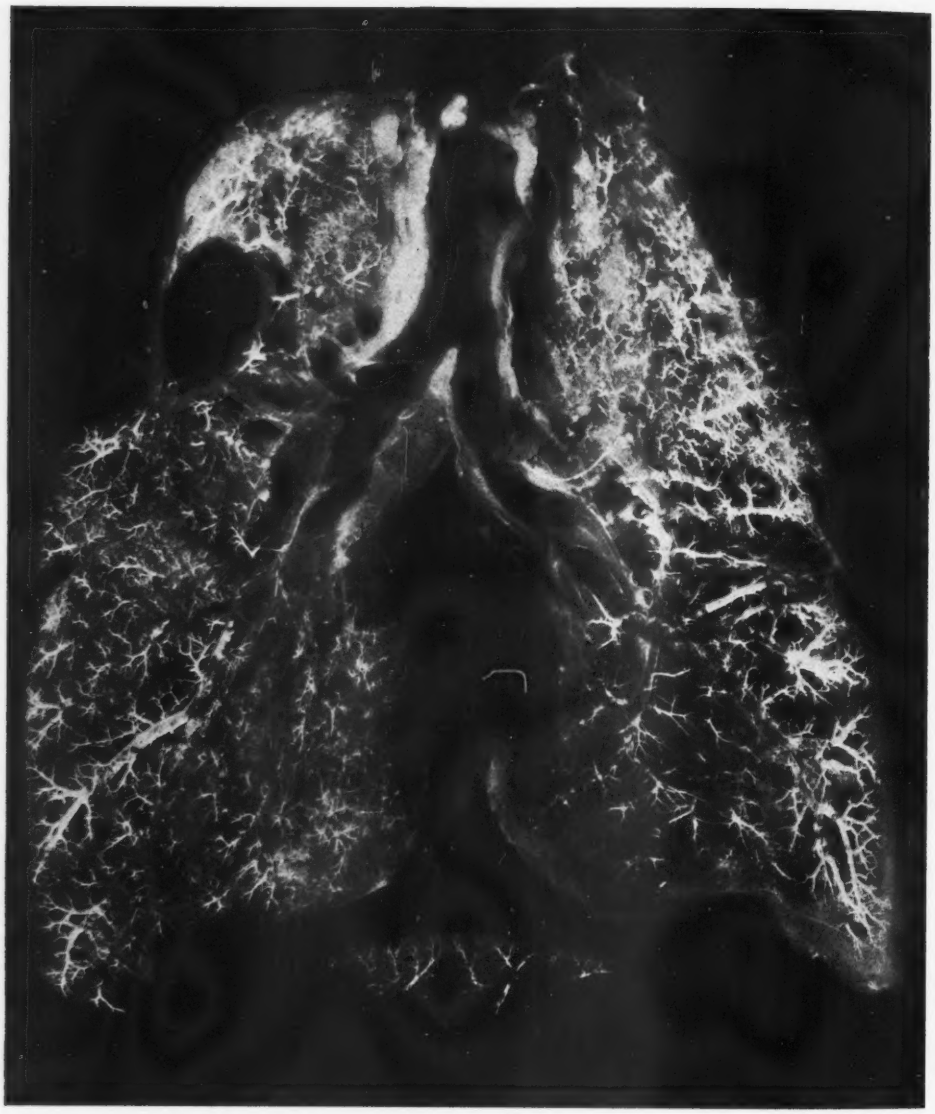


Plate 28. (Case No. 13351, Fig. 6.)

Section from fixed lungs. There is marked reduction of small vascular branches, which is more marked in the left lung in which the exudative disease was most marked on admission. The lack of efficient circulation in the apparently well aerated lung accounts for the patient's dyspnea and the hypertrophy of the right side of the heart.

RADIOTHERAPY FOR TUMORS OF THE TESTIS[1]

By EUGENE T. LEDDY, M.D., *and* ARTHUR U. DESJARDINS, M.D., *Rochester, Minnesota*
Section on Therapeutic Radiology, The Mayo Clinic

FROM 1920 to 1936, inclusive, 314 patients with malignant tumors of the testis were treated at the Mayo Clinic (Table I). More than half (172) of these tumors were encountered in patients in the so-called cancer age, that is, between the ages of thirty and fifty years (Table II). The youngest patient in the series, however, was three years old, the oldest 83; in neither case, however, was the microscopic diagnosis made at the Clinic.

The right testis was involved by the malignant tumor in 140 cases (45 per cent), the left in 165 cases (52 per cent). Both testes were said to be involved in four cases (1 per cent), but from the data available it was impossible to be sure whether both testes were actually involved simultaneously or, if not, which organ was to be regarded as the primary site of the lesion. The testis affected was not stated in the remaining five cases.

In regard to the significance of undescended testis as a possible etiologic factor the data may lead to false impressions. This condition was mentioned 15 times in the records of cases in this series. Similarly, the data concerning the relationship of direct trauma to the development of malignant tumor of the testis, mentioned in 23 cases, may lead to misinterpretations.

Most of these 314 patients came to the Clinic for consideration of their testicular lesion at least three months after they noticed something wrong with the organ; swelling of the testis was stated by 25 of the patients to have been present three years or more before the institution of treatment.

A well-known fact, but one which is frequently lost sight of, is that metastasis to the para-aortic nodes occurs much earlier and more frequently than is generally recognized; it occurred 180 times in this series of cases. This metastasis is generally to nodes in the vicinity of the celiac axis and usually on the same side as the testicular tumor. The spread tends to remain localized in these nodes for a considerable time, and usually precedes metastasis to the supraclavicular nodes and lungs. Occasionally, however (in about 1 per cent of the cases), metastatic elements instead of passing through the thoracic duct may lodge in the mediastinal portion of it, and by growing there form a unilateral or bilateral secondary tumor which may extend outward into the lungs. Metastatic involvement of nodes outside the abdomen always is a secondary phenomenon, and takes place after localization of metastasis in the abdominal nodes has been present for a considerable time. Under ordinary conditions, metastasis takes place to the retroperitoneal nodes, to the "pilot" supraclavicular nodes, and to the lungs or other organs, in that order. Involvement of the inguinal nodes occurs only when the testicular tumor has perforated the capsule of the organ (in 10 to 15 per cent of cases). Metastasis to the lungs, usually regarded as a common event, is actually uncommon

TABLE I.—MALIGNANT NEOPLASMS OF THE TESTIS (1920–1936): PATIENTS TREATED

		Total Patients
Orchidectomy at Clinic:		101
with irradiation	93	
without irradiation	8	
Irradiation only at Clinic:		207[2]
with previous orchidectomy	145	
without previous orchidectomy	62	
Irradiation with other operation at Clinic		6
		314

[1] Read before the Fifth International Congress of Radiology, Chicago, Sept. 13–17, 1937.

[2] Biopsy or exploration at Clinic in 23 cases.

TABLE II.—MALIGNANT NEOPLASMS OF THE TESTIS (1920–1936): AGE DISTRIBUTION

Age, years	Patients	Percentage
0–9	3	1.0
10–19	10	3.2
20–29	85	27.1
30–39	100	31.8
40–49	72	22.9
50–59	31	9.9
60–69	6	1.9
70–79	5	1.6
80+	2	0.6
Total	314	100

and was a relatively late complication in about 10 per cent of our cases.

One of our patients in addition to the testicular tumor had a tumor of the parotid gland and another had a tumor of the cheek. Metastasis to bones occurred in three cases, cerebral metastasis was present in five, and both were present together in two. The occurrence of a swollen, tender breast in a case of testicular tumor is not extremely rare; it occurred in seven cases in this series. That such may be evidence of carcinomatous involvement was shown by biopsy in one case; in the other six cases the mammary lesion was thought to be associated with some hormonal change and was not investigated further. These figures on the incidence of metastasis illustrate the difficulty of evaluating the results of any treatment of tumors of the testis.

The classification of tumors of the testis from a pathologic or cytologic point of view has likewise done little to clarify the situation clinically. What may be classified by one pathologist as a teratoma may be called a seminoma by another. Then again such terms as "spermatoblastoma," "spermatocytoma," "Sertoli cell tumor," and so forth, are of great cytologic importance and of great radiotherapeutic significance in indicating the sensitiveness of the tumor, but they may lead to confusion in terminology. With sufficient experience, it is true, one can form an estimate of the structure of a testicular tumor by its response to radiotherapy. But if one attempts to utilize the general response of these tumors to radium therapy or to moderate voltage roentgen therapy as a means of indicating the microscopic characteristics of a specific tumor of the testis, one is on very uncertain ground for it has not been proved that a radiosensitive tumor of the testis, such as the seminoma (or embryoma), responds in a like degree to radiation of such a qualitative difference. Furthermore, the difference in the quantitative doses employed in treatment by various workers makes comparisons even more uncertain.

In order most readily to evaluate the results of radiologic treatment in these 314 cases, we have regarded them as "proved cases" only when a microscopic diagnosis was made either at the Clinic or by the referring physician. This group includes cases in which orchidectomy was performed at the Clinic (101 cases) and cases in which microscopic examination and diagnosis were made on: (1) tissue other than testicular tissue which had been removed at the Clinic for biopsy, and (2) tissues removed, elsewhere, from the testis, and which had been sent to the Clinic or some other laboratory for pathologic examination, the patient from whom the specimen was removed subsequently receiving radiotherapy at the Clinic. "Unproved cases" include all those diagnosed definitely as malignant tumor of the testis but in which a microscopic diagnosis was not available.

From this point of view, therefore, we regarded 242 of the lesions as proved and 72 as unproved testicular tumors. Regardless of this limitation, all 314 lesions undoubtedly represented malignant tumors of the testis even though the diagnosis was not confirmed by microscopic examination. One might repeat, however, that 100 per cent of the cases in which orchidectomy was performed at the Clinic represent "proved" cases, and of those in which orchidectomy was performed elsewhere

63 per cent were "proved." In general the "unproved" cases were the more unfavorable ones because the lesions were of longer duration and had produced abdominal metastasis in 80 per cent of instances.

It would seem that the value of the radiotherapeutic treatment of testicular tumors would be mostly palliative. This is particularly true if one takes into account the technical modification and development of roentgen therapy. The outstanding characteristic of roentgen treatment, as given in the earliest years with which this report is concerned, was its insufficiency as judged in light of modern experience. Usually but a few small fields were irradiated by roentgen rays, these fields usually being distributed over the sacral region. The anterior abdominal fields were in general treated with radium packs. With the passage of time and with the acquisition of experience, however, more and more fields were added and the dosages of roentgen rays were increased. Finally, with the advent of apparatus operating at 200 kilovolts, voltages lower than 200,000 for a time fell into disuse. Simultaneously greater and greater demands were being made on the radium supply for the treatment of other types of lesions, and the treatment of patients with testicular tumors was carried out more and more by roentgen rays. Because there seemed to be no definite proof of the superiority of radiation of short wave lengths over that of moderate wave lengths, and because the knowledge of the paths of lymphatic drainage through which metastasis might take place necessitated extensive and perhaps unsafe irradiation with roentgen rays generated at 200 kilovolts, radiologic treatment, especially in the latter years, has been carried out largely with roentgen rays generated at 135 kilovolts and filtered, as a rule, through 6 mm. of aluminum.

With this type of radiation the abdomen is usually treated through four anterior fields, extending from the xiphoid to the pubis, one field being irradiated through each of the abdominal quadrants and through four posterior fields at corresponding levels. In addition to these, the left supraclavicular space is irradiated and also the mediastinum, even though roentgenograms of the thorax may not indicate metastasis. Each field receives a dose of about 550 r. This course of treatment takes from eight to sixteen or more days to complete, depending on the patient's tolerance to irradiation, as checked by his general physical condition and, especially, by the condition of the blood. This course of treatment is repeated in a month, even though metastasis cannot be demonstrated. When the reaction of the metastatic lesion or the microscopic report indicates true adult cancer of the testis, a third course of treatment is given. In this case the posterior fields are commonly treated with roentgen rays generated at 200 kilovolts.

As has been stated previously, the extent of the body which is irradiated has increased with an increasing knowledge of the paths of metastasis from malignant testicular tumors and with an increasing knowledge of the radiosensitiveness of various types of testicular lesions. To us, at least, it seems futile to devote one's attention to irradiation only of the groins, because metastatic involvement of the inguinal nodes is comparatively uncommon. Then, too, irradiation of the pelvis alone seems insufficient. Nor does it seem reasonable to use high voltage radiation, especially in large doses, as a routine because in about three-fourths of the cases the tumor is highly radiosensitive.

That the commonest tumor of the testis, the seminoma (or embryonal carcinoma), is radiosensitive is well known. Next in order of sensitiveness is the mixed (or teratoid) tumor which has a high content of undifferentiated cells. More resistant to irradiation are the adult carcinomas of the testis and the true teratomas with well differentiated cells. In the case of the last named, maximal doses may cause only slight and temporary regression, either of the primary testicular tumor or of its metastatic deposits.

It has been mentioned before that we regarded as "proved" cases only those in

TABLE III.—MALIGNANT NEOPLASM OF TESTIS (1920–1936): CASES IN WHICH THE PATHOLOGIC DIAGNOSIS WAS GIVEN

	Cases	Percentage of 314	Grade				
			1	2	3	4	Not stated
Adenocarcinoma	65	20.7	0	3	15	27	20
Adenocarcinoma with teratoma	22	7.0	1	3	13	4	1
Teratoma	21	6.7	0	0	0	0	21
Seminoma	76	24.2	0	0	0	74	2
Sarcoma	24	7.6	0	0	0	0	24
Embryoma	16	5.1	0	0	0	0	16
Miscellaneous	18	5.7	0	0	0	0	18
Total	242						

TABLE IV.—MALIGNANT NEOPLASMS OF THE TESTIS (AFTER 1919): THREE- AND FIVE-YEAR SURVIVALS, ACCORDING TO METASTASIS, FOLLOWING ORCHIDECTOMY AND IRRADIATION AT CLINIC

Group	Patients treated[3]	Patients traced	Lived three or more years after operation		Patients treated[3]	Patients traced	Lived five or more years after operation	
			No.	Percentage of those traced			No.	Percentage of those traced
With metastasis	23	23	9	39.1	22	22	7	31.8
Without metastasis	56	56	38	67.9	47	47	29	61.7

[3] Inquiry as of Jan. 1, 1937. The three-year group comprises patients treated three or more years prior to the time of inquiry (*i.e.*, 1933 or earlier); the five-year group comprises those treated in 1931 or earlier.

which the microscopic diagnosis was available. In this connection an explanation of the terms used here may serve to reconcile this classification with the usual ones which are based on the cytologic origin of the tumor. As used by Broders, the term "adenocarcinoma, Grade 4," includes all tumors with little cellular differentiation and with the greatest number of mitotic figures; it includes the tumors which are usually classified as embryomas or seminomas. Carcinoma, Grade 2 or 3, includes true carcinomas of the testis. Grade 1 tumors are the most benign. "Teratoma" means what the name implies (Table III).

From the foregoing, two facts are evident: (1) that the majority of lesions belonged to the group of highest malignancy, and (2) that the teratomas and the true carcinomas, which are usually regarded as radioresistant tumors, though in the minority, nevertheless were common.

Adenocarcinomas of Grade 4 are of the most malignant type. They grow most rapidly, exhibit the least cellular differentiation, and contain the largest number of mitotic figures. They are prone to metastasize and to recur. Yet the relative radiosensitivity of tumors of this group and the seminomas is admitted as the result of general experience. Teratomas and adult carcinomas of Grades 2 and 3, on the other hand, are less radiosensitive than Grade 4 adenocarcinomas of the testis. No generalizations can be made about the response to be expected from roentgen therapy.

To judge by the analogy of malignant tumors in general, the group of cases without metastasis is to be regarded as the

TABLE V.—MALIGNANT NEOPLASMS OF TESTIS (AFTER 1919): THREE- AND FIVE-YEAR SURVIVALS ACCORDING TO TYPE OF TREATMENT

Group	Patients treated[4]	Patients traced	Lived three or more years after operation: No.	Lived three or more years after operation: Percentage of those traced	Patients treated[4]	Patients traced	Lived five or more years after operation: No.	Lived five or more years after operation: Percentage of those traced
Orchidectomy at Clinic:								
with irradiation	72	72	43	59.7	64	64	34	53.1
without irradiation	7	7	4	57.1	5	5	2	40.0
Irradiation[5] only at Clinic:								
with previous orchidectomy	117	116	23	19.8	97	96	13	13.5
without previous orchidectomy	51	51	10	19.6	47	47	7	14.9

[4] Inquiry as of Jan. 1, 1937. The three-year group comprises patients treated three or more years prior to the time of inquiry (*i.e.*, 1933 or earlier); the five-year group comprises those treated in 1931 or earlier.

[5] Includes other operations, exploration, and biopsy.

most favorable. But in estimating the value of treatment in this group one must keep in mind the fact that among all those cases in which the microscopic diagnosis was known (242 cases), 42 lesions were graded as adenocarcinomas of the most malignant types (Grades 3 and 4).

In view of the many factors involved, this statistical analysis does not give a clear idea of the value of radiotherapy. Earlier in this paper we have given our reasons for regarding radiotherapy for testicular tumors more as a palliative than as a curative procedure. In 56 of the 314 cases, the results of radiotherapy were regarded as failures; that is, the benefit derived from it was trivial or doubtful and lasted less than six months. Failure was due to one or more of three reasons: (1) the disease was far advanced (in all of these 56 cases abdominal metastasis was extensive and in 15 cases was accompanied by pulmonary metastasis); (2) in all 56 cases the treatment was incomplete—usually because of the fact that the condition of the patient precluded adequate radiotherapy, and (3) in the cases in this group in which microscopic grading of the tumor had been made, the tumors had been graded 3 or 4 and frequently were associated with a teratoma. We feel, therefore, that these cases constituted the most advanced and most unfavorable group for treatment, and one for which radiotherapy even under ideal conditions could hardly be expected to yield impressive results.

The importance of the presence or absence of metastasis in regard to prognosis after treatment is shown in Table IV. From this table it is self-evident that about twice as many patients (61.7 per cent) without metastasis survived treatment for more than five years as did those who did show metastasis (31.8 per cent). In both these groups of cases it should be noted that *all* patients underwent orchidectomy at the Clinic and that *all* of these patients were traced.

Table V indicates the value of radiotherapy as a method additive to operation in that it apparently increased survivals

by 13 per cent (from 40 to 53.1 per cent) in those cases where it was given. It should be noted, however, that the two groups are not strictly comparable numerically. A further, and perhaps more conclusive, indication of the value of radiotherapy is given in Table IV, which shows that about 32 per cent of the patients with metastasis lived five years or longer after treatment.

SUMMARY

The cases of 314 patients with malignant testicular tumors are reviewed with special reference to the survival of such patients following treatment.

The most important factors influencing prognosis are the type of the tumor and the presence or absence of metastasis at the time of treatment. A patient without metastasis has about a 60 per cent chance of surviving for five years or longer; with metastasis, his chances are about 30 per cent of surviving for the same period.

We would like particularly to express our thanks and appreciation to Dr. A. C. Broders and Dr. Joseph Berkson for their valued assistance in the preparation of this paper.

THE DETECTION OF CRYSTALLINE SILICA IN LUNG TISSUE BY X-RAY DIFFRACTION ANALYSIS[1]

By HENRY C. SWEANY, M.D., ROSALIND KLAAS, PH.D., *and* GEORGE L. CLARK, PH.D.

From the Research Laboratories of the City of Chicago Municipal Tuberculosis Sanitarium, and the Department of Chemistry, University of Illinois

THE subject of pneumonoconiosis includes a wide range of disease conditions resulting from the inhalation of some type of dust. It has been known for many years that the clinical findings, as well as the pathology, vary roughly according to the particular irritants, and that the conditions resulting from their inhalation may be sharply divided into two groups, *viz.*: those that produce a specific fibrosis in the peribronchial lymphatics and the parenchyma of the lung, and those that do not produce this "exuberant granulation tissue" but cause detriment more slowly as a foreign body that interferes with the lymph drainage and cleaning facilities of the lung. In the former, there is a gradual impairment of the total alveolar surface of the lung, together with an encroachment upon the lymph drainage; in the latter, there is only encroachment upon the lymph drainage. The former is much more serious as a disease process *per se*, as well as a soil for the growth of the tubercle bacillus which causes tuberculosis.

These two conditions (the former is best represented by silicosis and the latter by pure anthracosis) may be combined in varying proportions, with or without an accompanying infection, such as tuberculosis. Practically all types of pneumonoconiosis are described in the report of Sweany, Porsche, and Douglass (1). A rough relationship was established between the pathology and the amount of silica found by chemical analyses of lungs and lymph nodes. In the majority of cases the amount of specific fibrosis corresponded roughly to the silica content; in others there seemed to be little or no positive correlation. In those cases wherein a high silica content was not accompanied by a specific fibrosis, it was thought that the condition might be attributed to one or more of the following factors:

(1) The dampening effect of inert dusts such as coal and iron. There seems to be but little doubt that inert dusts delay the action of silica, if they do not actually dampen it completely. This conclusion is supported by the findings in coal miners reported by Sampson (2), Cummins (3), and others.

(2) A time interval following exposure that is not sufficiently long to permit the development of fibrosis.

(3) The presence of non-toxic silicates. In some instances the quantity of silica indicated by chemical analysis was too large to fail to produce fibrosis, irrespective of circumstances.

In view of the above considerations, it is evident that there is great need in industrial medicine for a method which will enable us to distinguish the detrimental type of silica (usually thought to be quartz) from silicates, which yield silica upon chemical analysis. Chemical methods thus permit only the estimation of total silica; they do not make it possible to differentiate between free and combined silica, or

[1] For making it possible to carry out this work, we wish to express our gratitude to the Board of Directors of the Municipal Tuberculosis Sanitarium, consisting of Frederick Tice, M.D., President; Mr. Harry J. Reynolds, Vice-president, and Allan J. Hruby, M.D., Secretary.

We also desire to express our appreciation to Dr. Ben C. Sher, Chief Chemist of the Municipal Tuberculosis Sanitarium Laboratory, for valuable suggestions; to Mr. William L. M. Martinsen for photographic reproductions; to Dr. J. N. Mrgudich and Dr. N. C. Shieltz of the Chemistry Department, University of Illinois, for their assistance in producing the x-ray patterns.

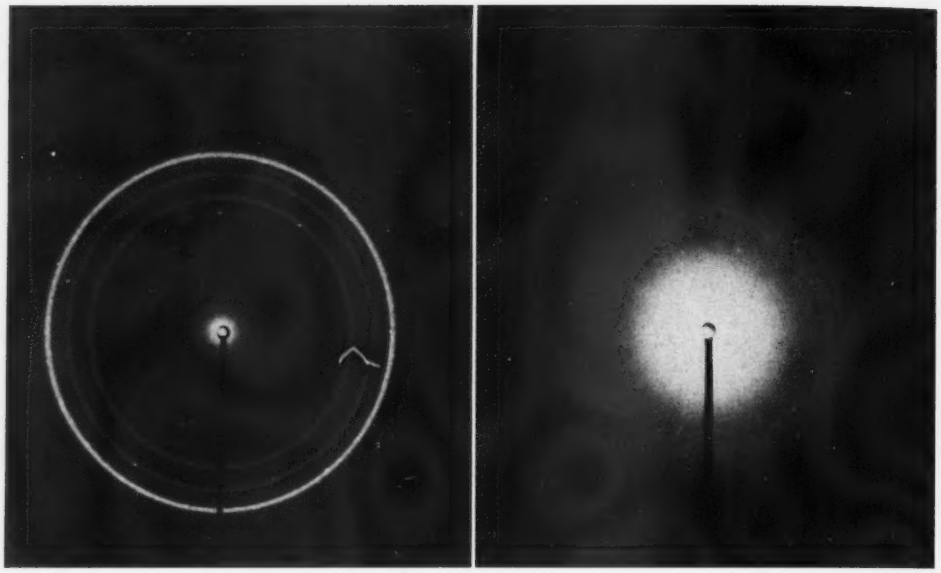


Fig. 1 (*left*). Quartz.
Fig. 2 (*right*). Case 1. Infant. Silica, 0.09 per cent.

between crystalline and amorphous silica. Petrographic methods are often valuable aids in the identification of crystalline compounds, but they are applied only with extreme difficulty when the particles have a diameter of less than five microns. Because of the inadequacies of these methods, we have turned our attention to the use of x-ray diffraction analysis for the detection and identification of the crystalline compounds present in lung tissue. A preliminary report of several of the cases examined has been given (4). We are now presenting a more detailed report of the series of cases that we have thus far investigated.

Some of the earlier applications of x-ray diffraction analysis to the field of pneumonoconiosis may be reviewed briefly here. Bale and Fray (5) used this method to identify quartz in dusts; Clark and Reynolds (6) developed a modification which permits the quantitative determination of the amount of quartz in mine dusts. The water-insoluble inorganic constituents of lung tissue remaining after a digestion with trypsin were collected, dried, and subjected to the x-ray analysis by Hicks, McElroy, and Warga (7). After this concentration procedure, quartz was found in small amounts in lungs showing no signs of silicosis. The silica content of the dry tissue varied from 0.07 to 0.23 per cent; in none of their cases was there pathologic evidence of silicosis. Sundius, Bygden, and Bruce (8) collected the residue after a hydrogen peroxide digestion of the lung tissue of an earthenware worker, and found that it gave the same x-ray pattern as did the dust from the pottery factory in which he worked. However, they did not attempt the identification of any constituents on the basis of the patterns obtained. Kahane and Antoine (9) show x-ray patterns of quartz in the residues of lungs after nitric-sulfuric-perchloric treatment, but they do not describe the pathology of the cases. Very recently Jephcott, Gray, and Irwin (10) have made a study of the siliceous fraction of 35 lung ashes of persons exposed to various types of siliceous dusts. They found quartz as a chief constituent of all the lung ashes examined.

In the present investigation, samples of

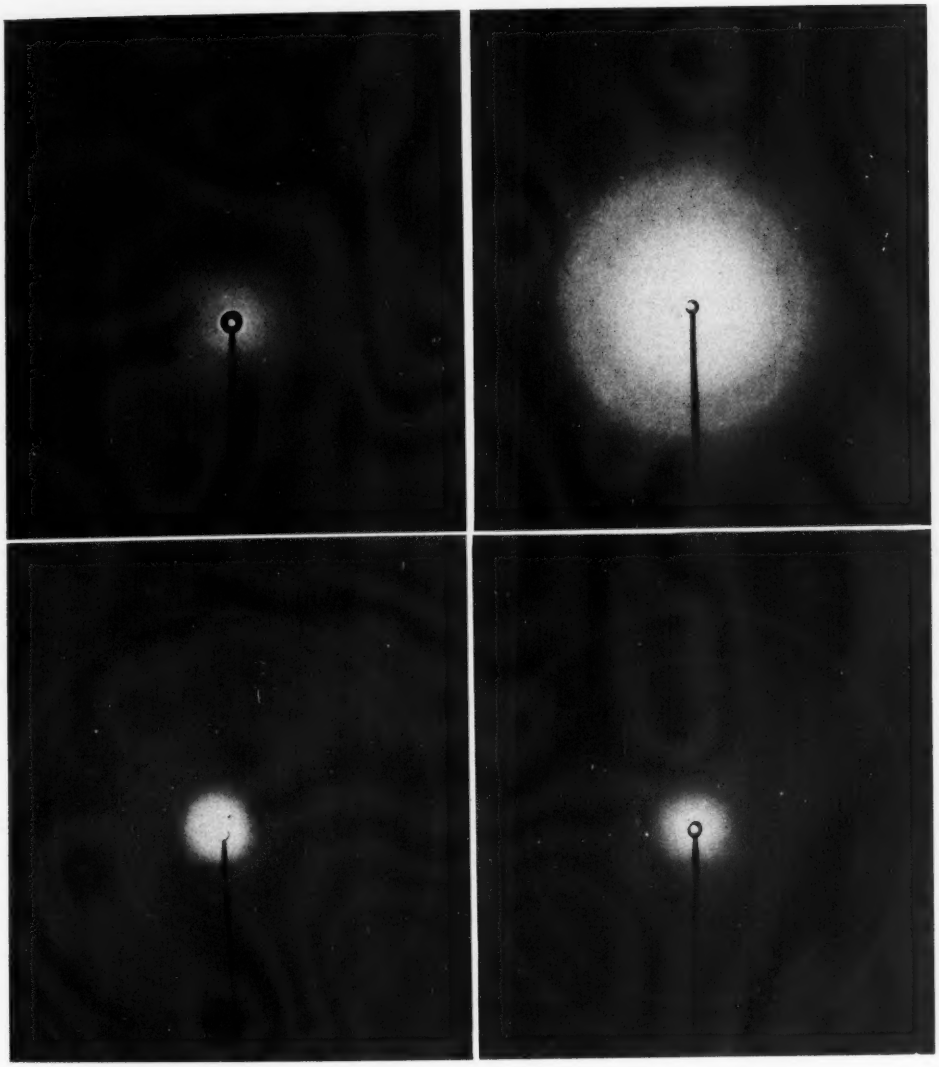


Fig. 3 (*above left*). Case 3. Housewife with pulmonary tuberculosis. Silica, 0.05 per cent.
Fig. 4 (*above right*). Case 5. Farmer with multiple tuberculous calcifications, but no silicosis. Silica, 0.63 per cent. No quartz lines present.
Fig. 5 (*below left*). Typical tuberculous calcification.
Fig. 6 (*below right*). Powdered bone.

lung tissue from a wide variety of cases were subjected to x-ray diffraction analysis. Previous to the chemical analysis, the results of which have already been published (1), the lung tissue had been hardened in a dilute solution of formaldehyde, dried *in vacuo* at 70° C., ground to pass a 40-mesh sieve, and dried further to constant weight at from 105 to 110° C. For the x-ray study very thin samples were prepared by packing the powdered tissue into disks from 0.2 to 0.3 mm. in thickness. The x-ray beam, collimated by two 0.010-inch pinholes, was supplied by a Philips Metalix tube with a copper target, operating at 20 ma. and 27 kv. p. The film

was held in a flat holder at a distance of 5.0 cm. from the sample. The exposure time was usually seven hours. This length of time was made necessary by the use of very thin samples, but with this type of sample the pattern of the inorganic constituents was not masked by the effects of the large amount of organic material present.

Figure 1 shows the pattern of quartz. It is important to note the great intensity of the 3.34 Å.U. spacing. It is this line which persists even when the amount of quartz present in the tissue is very low. With our present technic we have been able to detect quartz in samples in which the total silica, as given by the chemical analysis, was as low as 0.26, 0.22, and 0.20 per cent. The threshold sensitivity of the method thus appears to be in the neighborhood of 0.2 per cent.

The lung tissue itself gives rise to a broad halo about 3.6 cm. in diameter and to more or less scattering about the central spot. These are the only effects noted in Figures 2 and 3. The specimen producing the pattern shown in Figure 2 was the lung of an infant (Case 1), giving upon analysis a silica content of 0.09 per cent. Case 2, another infant, with 0.16 per cent silica, gave the same pattern. No essential difference is to be noted in the pattern of Case 3 (Fig. 3), a 46-year-old housewife dying of fibrocaseous and ulcerative pulmonary tuberculosis. The silica content here was only 0.05 per cent. Case 4, silica 0.11 per cent, was that of a 56-year-old nurse having a normal adult lung. The pattern showed several lines, none of which could be ascribed to the spacings of quartz.

Case 5 (Fig. 4) was that of a 72-year-old man who had farmed all his life. There were multiple healed ossified tuberculous calcifications throughout both lungs. Although the silica content was 0.63 per cent, no quartz lines were observed in the x-ray diffraction pattern. Instead, the pattern closely resembled that of a typical tuberculous calcification (Fig. 5). Note also the close similarity to the pattern of powdered bone (a piece of human rib, Fig. 6). Although the silica content was six times that of the normal lung and three times the amount usually producing silicosis, no pathologic evidences of the disease were found. On the basis of the x-ray findings, we may conclude that the silica indicated by the chemical analysis was probably largely derived from silicates. We thus have a possible explanation of the fact that no silicotic condition existed even though the silica content was high.

In the above group of controls, no quartz lines were found in the x-ray patterns. Let us now turn our attention to a group of cases of silicosis. Case 6 was a 35-year-old Bohemian millstone sharpener exposed to dust for 8.5 years and dying with an extensive pure silicosis. The lungs had a silica content of 0.61 per cent and gave an x-ray pattern showing not only the 3.34 Å.U. spacing of quartz, but also the 4.25 Å.U. spacing (Fig. 7).

Case 7 was a 78-year-old coal and lead-zinc miner of long exposure, who had an anthraco-silicosis. The silica content of the lung tissue was 0.94 per cent, and the x-ray pattern showed clearly the 3.34 Å.U. spacing of quartz (Fig. 8).

Case 8 was a 39-year-old man who had worked in a stone quarry for nine years. He was out for 15 years and finally died of a silico-tuberculosis. However, there was only a slight amount of silicotic fibrosis confined to the lymph nodes, with an almost pure tuberculosis in the parenchyma. Chemical analysis showed only 0.36 per cent silica; a very faint quartz line was visible on the x-ray film.

Case 9 was a 45-year-old rock miner who had worked as such for 18 years. He had a well-developed silico-tuberculosis, both grossly and microscopically. There was found 1.03 per cent silica upon chemical analysis of the lung, and the x-ray pattern showed the quartz line together with other lines as yet not identified (Fig. 9).

Case 10 was a 54-year-old stone cutter who had worked at the trade for 33 years. There was a typical silico-tuberculosis with ulceration (silica content, 1.22 per

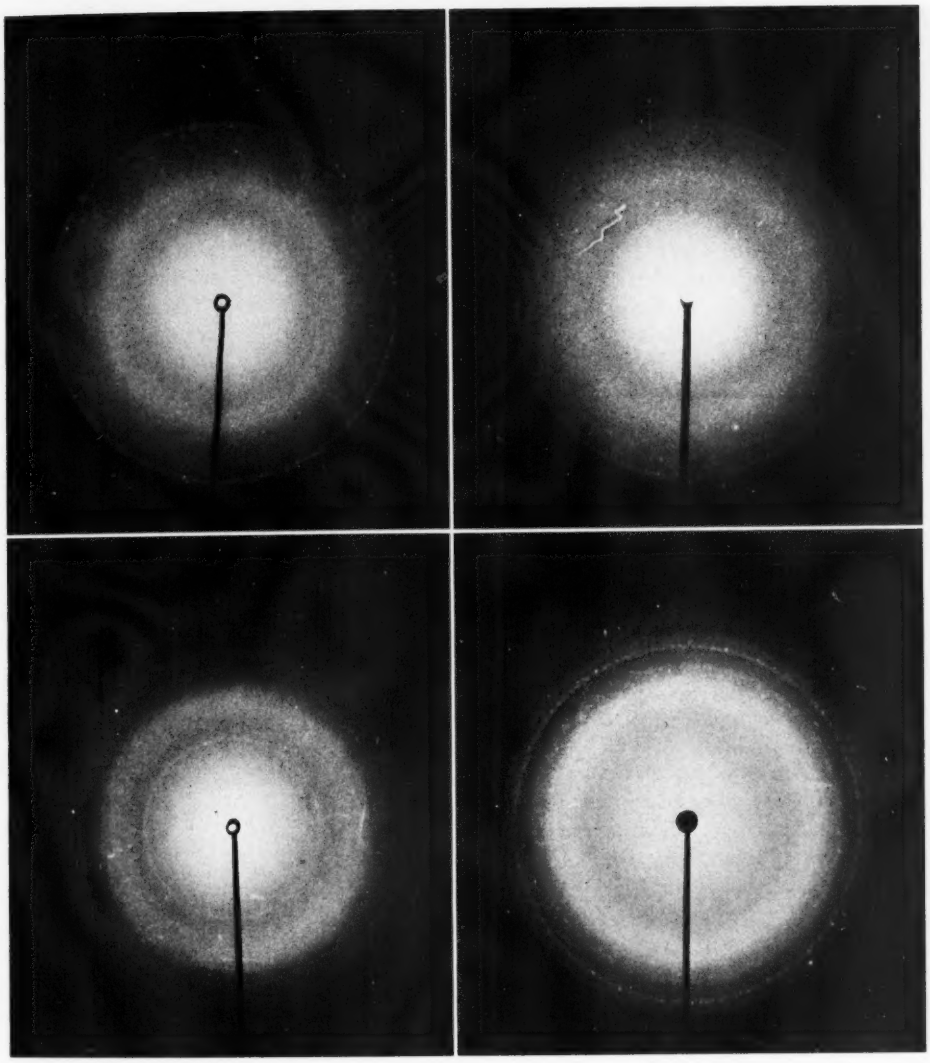


Fig. 7 (*above left*). Case 6. Millstone sharpener with silicosis. Silica, 0.61 per cent.
Fig. 8 (*above right*). Case 7. Lead and zinc miner with anthraco-silicosis. Silica, 0.94 per cent.
Fig. 9 (*below left*). Case 9. Rock miner with silico-tuberculosis. Silica, 1.03 per cent. Quartz line indicated by arrow.
Fig. 10 (*below right*). Case 10. Stone cutter with silico-tuberculosis. Silica, 1.22 per cent.

cent). Strong quartz lines were present in the x-ray pattern, with other unidentified lines (Fig. 10).

Case 11 was a 29-year-old man who claimed to have worked in a "cement factory" for a period of six months, ten years before his death. No hint of silico-tuberculosis was obtained until the postmortem examination, when the advanced disease was found. There was 0.26 per cent silica in the lung parenchyma, and a definite quartz line on the film. A search into this boy's record revealed the fact that the "cement factory" was that only in name.

In this "factory" high school boys were employed to grind silica for the manufacture of abrasives.

Case 12 was a 48-year-old stone cutter who had a silico-tuberculosis. Chemical analysis of the lung showed a silica content of 2.46 per cent and a large amount (1.16 per cent) of residue non-volatile with hydrogen fluoride (probably refractory silicates). The x-ray pattern (which was practically identical with that shown in Fig. 10) indicated a mixture of quartz with other crystalline substances.

Case 13 was a 62-year-old lead and zinc miner who had worked as such for 17 years. The pathology was that of silico-tuberculosis. The silica content of the tissue was 0.63 per cent. In this case, as well as in the next five (14 to 18, inclusive), there was practically no residue after the hydrogen fluoride treatment of the acid-insoluble material. Diffraction analysis showed definitely the 3.34 Å.U. spacing of quartz.

Case 14 was a 65-year-old lead and zinc miner who had been in the trade for 40 years. There was an advanced silico-tuberculosis, with a chemical analysis of 0.90 per cent silica. The presence of quartz was established by the x-ray diffraction analysis.

Case 15 was a 55-year-old lead and zinc miner who had worked at the trade for 33 years and died of silico-tuberculosis. The chemical analysis revealed 1.13 per cent silica, and the x-ray pattern revealed the 3.34 Å.U. spacing of quartz.

Case 16 was a 48-year-old lead and zinc miner who had worked as such for "many" years. He died of silico-tuberculosis. The silica content of the lung was 1.57 per cent. In the x-ray pattern (Fig. 11) only the strong line of quartz was present. The patterns of Cases 13, 14, 15, and 17 were practically identical with this one.

Case 17 was a 58-year-old lead and zinc miner who had worked 15 years in the mines. Death was due to an anthraco-silico-tuberculosis. Chemical analysis showed 0.51 per cent silica, and the x-ray pattern the characteristic spacing of quartz.

Case 18 was a man who had worked 11 years in coal mines, followed by eight years in the lead and zinc mines. There was an anthraco-silico-tuberculosis, with 1.12 per cent silica in the lung tissue. Quartz and other substances were revealed upon x-ray diffraction analysis.

The most significant group studied was the one that was termed "borderline silicosis," in which were placed the cases that had histories of exposure to small amounts of dangerous dust or large amounts of questionably injurious dusts. In many of these cases there was also a doubtful gross and microscopic pathology. The amount of silica, as determined by chemical analysis, varied greatly, falling below the amount considered pathologic in many, and rising to double that level in others. In some of those above the pathologic level, no quartz pattern was found. This result suggests, therefore, that the x-ray diffraction analysis affords a selective separation of the harmful silica (quartz) from the relatively harmless silicates.

Case 19 was a 27-year-old machinist who had worked at his trade for seven years. The gross diagnosis was a more or less questionable silico-tuberculosis with many calcified tuberculous nodules. The microscopic search found nodular tubercles that were typical of tuberculosis rather than silicosis. In fact, there was such a lack of resemblance to silicotic fibrosis that the gross diagnosis was reversed. The chemical analysis revealed 0.13 per cent silica with considerable non-volatile residue. The x-ray pattern, which was given double the usual exposure time (15 hours), showed the 3.34 Å.U. spacing of quartz, together with the pattern of a tuberculous calcification. This man perhaps had done some sandstone grinding in his work as a machinist, although this detail was not mentioned in his rather sketchy case history.

Case 20 was a 60-year-old boiler maker in the lead and zinc mines. The gross

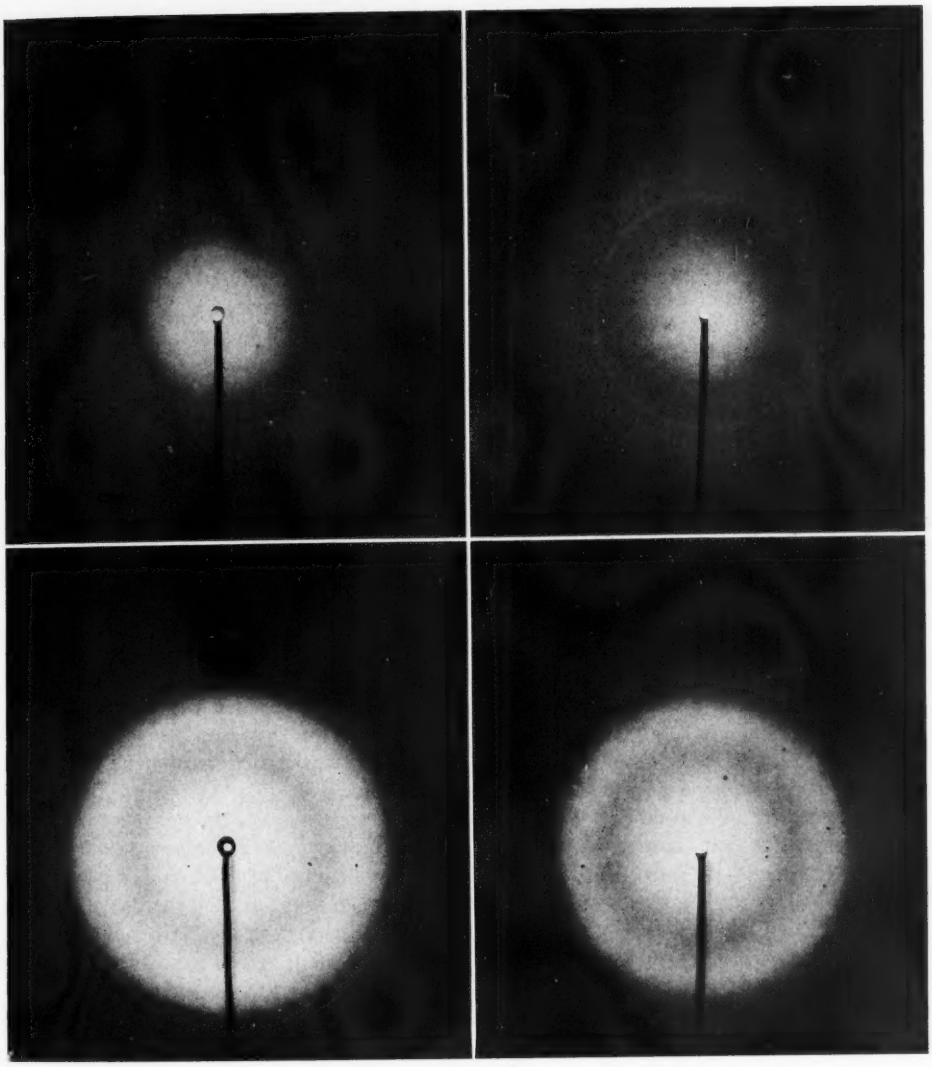


Fig. 11 (*above left*). Case 16. Lead and zinc miner with silico-tuberculosis. Silica, 1.57 per cent.
Fig. 12 (*above right*). Case 23. Coal miner with anthracosis. Silica, 0.42 per cent.
Fig. 13 (*below left*). Case 24. Engineering draftsman with tuberculosis. Silica, 0.14 per cent.
Fig. 14 (*below right*). Case 25. Blacksmith and tool maker with silico-tuberculosis. Silica, 0.22 per cent.

diagnosis, which was confirmed microscopically, was anthracosis and carcinoma of the (right) lung. The chemical analysis revealed 0.15 per cent silica, with twice that amount of non-volatile residue, in the left lung where carcinoma tissue was absent. The x-ray pattern did not show any quartz lines. We should expect this result, because, in general, boiler makers do not come into contact with silica in their work.

Case 21 was a 64-year-old janitor, working as such for 45 years. Anthracosis, bronchiectasis, and mild bronchopneumonia were found at postmortem. Chemical analysis revealed 0.17 per cent silica

with considerable non-volatile residue. No quartz lines were present in the x-ray pattern.

Case 22 was a 59-year-old molder who had worked at that trade for "many" years. There was mild pneumonoconiosis with emphysema. Upon chemical analysis there was found 0.18 per cent silica, with considerable non-volatile residue. Quartz lines were absent in the x-ray pattern.

Case 23 was a 45-year-old coal miner who had worked as such for 20 years. He had a positive Wassermann. There was a marked anthracosis present, with 0.42 per cent silica (and an almost equal amount of non-volatile residue). Figure 12 shows the x-ray pattern, which is probably that of some silicate mineral. Quartz is absent.

Case 24 was a 56-year-old engineering draftsman who had a gross fibroid type of lung in the apices, the gross pathology of which appeared like silicosis, but the microscopic appearance was not typical of it. The chemical findings gave 0.14 per cent silica. The x-ray pattern is reproduced in Figure 13. No lines were present. This pattern is typical of the patterns obtained in Cases 20, 21, and 22. It is probable that there was a fibroid type of tuberculosis present simulating a silico-tuberculosis, and that there was little or no silicosis.

Case 25 was a 57-year-old blacksmith and tool maker who had worked as such for 30 years. There was a widespread tuberculosis with many scattered nodules of silico-tuberculosis; this diagnosis was confirmed by the microscopic examination. The silica content was 0.22 per cent, and quartz was definitely indicated by the x-ray pattern (Fig. 14).

Case 26 was a 56-year-old man who had worked as a "hoister" in a lead and zinc mine for 16 years. Only a tuberculosis was shown grossly, but microscopically there was definite evidence of the phagocytosis and early fibrosis characteristic of the preliminary reactions in silicosis. Since there were no fibrotic whorls, a diagnosis of silico-tuberculosis could not be made. Chemical analysis showed 0.24 per cent silica, while the x-ray pattern gave a faint indication of quartz. This man was probably inhaling sufficient quartz to have caused the ultimate development of silicosis.

Case 27 was a 41-year-old "chef and copper miner"; there was no definite time stated for either period of occupation. Gross examination revealed a fibroid tuberculosis, while microscopically a few silicotic whorls were apparent. The silica content was 0.34 per cent with a faint indication of quartz on the x-ray pattern.

Case 28 was a 42-year-old molder in a brass foundry. He had worked as such for six years. There was a gross appearance of tuberculosis and a few microscopic whorls of silico-tuberculosis. The chemical ana ysis revealed 0.41 per cent silica with an equal amount of non-volatile residue. The strong line of quartz was not present in the x-ray pattern, although a number of other lines were present.

Case 29 was a 60-year-old molder who had worked as such for 35 years. There was a gross pathologic diagnosis of tuberculosis, but microscopically there was unquestionably a silicotic taint to the fibrosis. Chemical analysis showed 0.54 per cent silica, while the x-ray pattern had a very distinct 3.34 Å.U. line of quartz.

Case 30 was a 42-year-old "foundry worker and coal miner" who had worked at the two occupations for 23 years. There was a gross pathologic diagnosis of tuberculosis and anthracosis, but a few silicotic whorls were found microscopically. Chemically, there was 0.56 per cent silica with much non-volatile residue. A mixture of substances, which included quartz, was demonstrated by the diffraction analysis.

Case 31 was a 27-year-old "lead and zinc miner" who had worked as such for eight years with the protection of safety devices. There was the gross appearance of a tuberculosis with a few early whorls of silico-tuberculosis. The chemical analysis revealed 0.20 per cent silica with no non-volatile residue. The 3.34 Å.U. line of quartz was just barely visible on the x-ray film.

DISCUSSION

The results of these experiments seem to show that there is a close parallelism between the presence of silicotic fibrosis and the presence of quartz as determined directly on lung tissue by the interpretation of the x-ray diffraction pattern. In several of the cases investigated (Nos. 26, 27, 29, 30, and 31) the pathology was slight and at times doubtful; yet there was sufficient indication that the threshold of danger was approaching. In normal lungs and unexposed lungs the quartz lines were uniformly absent. In some cases, particularly Case 5, the large amount of silica was probably chiefly due to silicates.

While the general results of these experiments seem to indicate that x-ray diffraction analysis has found a place in the determination of detrimental silica in lung tissue, it must be pointed out that application of the technic is still in the experimental stage. There would seem to be great possibilities for its use in this field of pathology, but until further studies have been made we would counsel caution in expecting more than preliminary data would warrant at the present time. Some of the limitations may well be pointed out. First of all, the method, although sharply specific, is thus far only qualitative. However, in all probability it can be developed on a quantitative or a semiquantitative basis. Work in that direction is now in progress. Second, our experiments have been confined chiefly to lung tissue, with a few analyses on lymph nodes. The determination, therefore, is applicable only to *patients who have died*. It is our hope to apply the method to body fluids, particularly sputum, where it seems highly probable that results of some value may be obtained, although it must be recognized that many patients with dangerous silicosis may not have sputum at all.

In retrospect of this work, as well as the dust problem in general, we should like to say that the method of determination of quartz in mine dust, as described by Clark and Reynolds (6), has vast possibilities in the evaluation of the hazards of working conditions. Perhaps no other single operation will tell so much about the dangers of dust. No dust analysis should be considered complete without an x-ray diffraction analysis to show when quartz is present, the amount, and the size of particles.

CONCLUSIONS

As a result of this work we may conclude that, with the technic described, *the finding of quartz lines in the x-ray diffraction pattern of dried and ground lung indicates the presence of sufficient quartz to produce, or to have already produced, silicotic fibrosis.*

The use of x-ray diffraction methods, particularly in the detection of finely divided quartz particles, appears to afford an accurate and absolute means of detecting that substance in concentrations down to 0.2 per cent.

The method seems a logical one to use in differentiating silicosis from other dust diseases, and accordingly may very well become of major importance in medicolegal work.

BIBLIOGRAPHY

(1) SWEANY, H. C., PORSCHE, J. D., and DOUGLASS, J. E.: Arch. Path., **22,** 593, November, 1936.
(2) SAMPSON, H. L.: Silicosis Symposium. Saranac Lake, N. Y., 1934.
(3) CUMMINS, S. L.: Jour. Hyg., **36,** 547, October, 1936.
(4) KLAAS, R., SWEANY, H. C., MRGUDICH, J. N., and CLARK, G. L.: Science, **86,** 544, Dec. 10, 1937.
(5) BALE, W. F., and FRAY, W. W.: Jour. Indust. Hyg. and Toxicol., **17,** 30, 1935.
(6) CLARK, G. L., and REYNOLDS, D. H.: Jour. Ind. and Eng. Chem., Analyt. Ed., **8,** 36, Jan. 15, 1936.
(7) HICKS, V., MCELROY, O., and WARGA, M. E.: Jour. Indust. Hyg. and Toxicol., **19,** 177, April, 1937.
(8) SUNDIUS, N., BYGDEN, A., and BRUCE, T.: Trans. Ceramic Soc., **35,** 167, April, 1936.
(9) KAHANE, E., and ANTOINE, G.: Bull. Soc. Chim. Biol., **18,** 1769, December, 1936.
(10) JEPHCOTT, C. M., GRAY, W. M., and IRWIN, D. A.: Can. Med. Assn. Jour., **38,** 209, March, 1938.

A DOSAGE CHART FOR X-RAY THERAPY

By EDITH H. QUIMBY, M.A., Memorial Hospital, *New York City*

ACCORDING to the recommendations of the Radiological Society of North America and of the American Roentgen Ray Society, through their Standardization Committees, x-ray machines in America are calibrated according to their output in air at some specified distance, usually 50 cm. The International Committee for Radiological Units, at the Fifth International Congress of Radiology (Chicago, 1937), made the additional recommendation that x-ray doses should be specified in terms of the numbers of roentgens delivered to the various skin fields. In order to obtain from calibration data the number of roentgens delivered to the skin in a given time, or the time required for the administration of a specified number of roentgens, it is necessary to have available a table of back-scatter values for any qualities of radiation and fields which may be used, and to perform two or three simple arithmetical operations.

It is customary in many radiation departments to tabulate the irradiation times for the most frequently used distances, fields, and doses. A different table is necessary for each machine, unless two happen to have the same output. Such a table must be prepared or revised every time the output is changed for any reason, and it seldom covers a complete range of distances and fields.

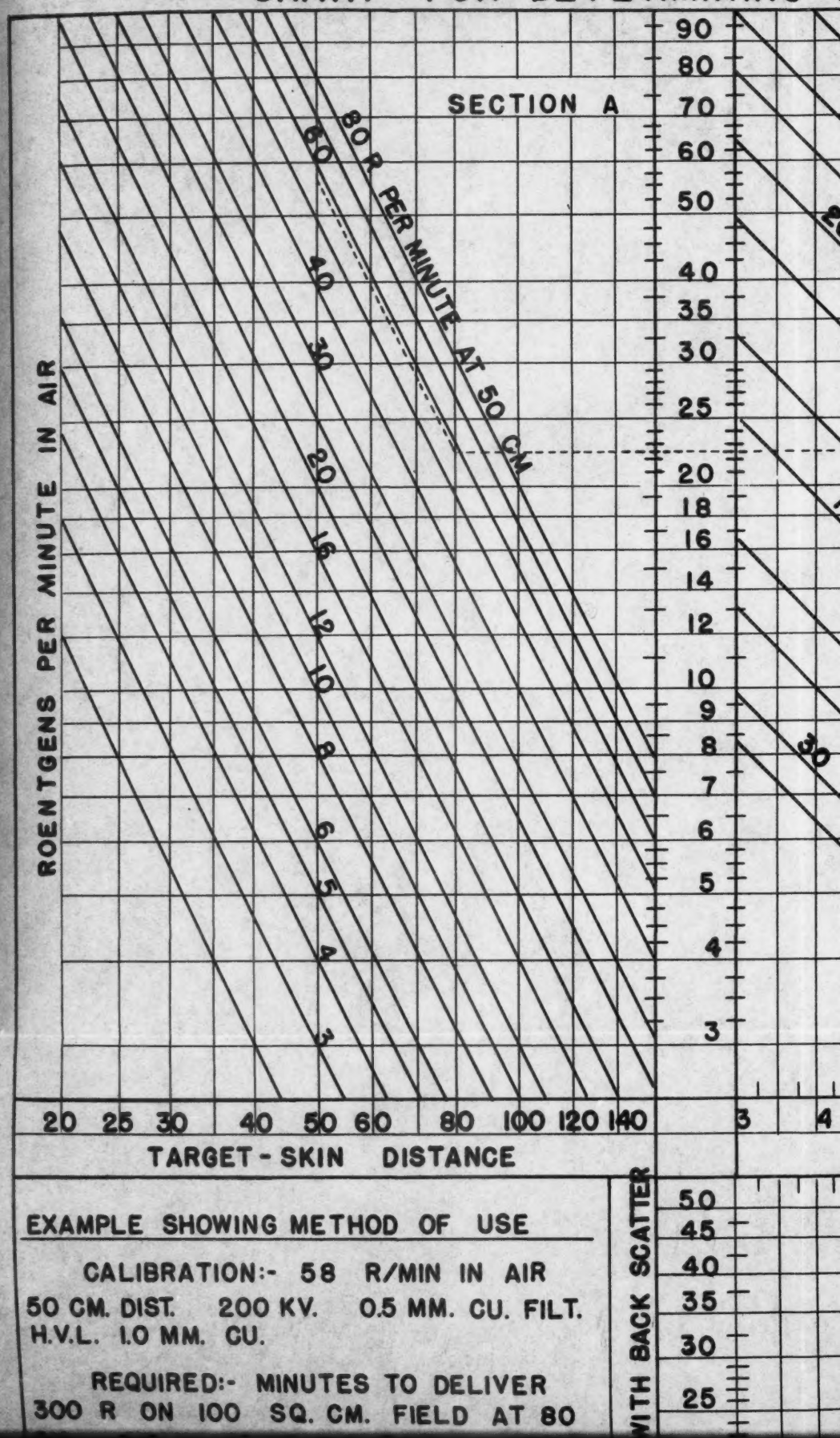
It was thought that a chart which would supply the time required for the delivery of any specified dose, either in air or on a skin field of any size, for any target-skin distance, would be a convenience. Such a chart is given in Figure 1.

The chart looks complicated, but it consists in reality of three simple sections, each of which can be used independently or in conjunction with the others. The fact that logarithmic scales are used makes the spacing appear unusual, but, since actual values and not logarithms are indicated, no confusion need arise for this reason.

Section A consists of parallel straight lines which provide for the determination of the roentgens per minute delivered in air at any distance, provided the output is known for any other distance, within the range in which the inverse square law holds. (This usually means in practice from about 10 to 15 cm. outside the tube holder, up to any desired distance.) The operation performed by this section, therefore, is that of applying the inverse square law to the air calibration, if treatment is to be administered at some distance other than that for which the calibration was made. To use this section for this purpose, the distance at which the calibration was made is found on the scale at the bottom of the section, and the corresponding r per minute on the scale at the side. The point thus determined will lie on (or near) one of the oblique lines. Other points on this oblique line indicate the r per minute at other distances, for the particular set-up in question. For example, for an output of 20 r per minute at 50 cm., that at any other distance may be found by following along the oblique line which passes through 20 r per minute at 50 cm. At 40 cm. this indicates 31.5, at 70 cm., 10, etc. If the calibrated value does not fall exactly on a line, the one nearest it can be used, a slight allowance being made to correct for the difference.

Section B consists of parallel straight lines which provide for the determination of the time necessary for the delivery of any specified number of roentgens in air, when the output of the machine in roentgens per minute is known. That is, the operation performed by this section is the division of the total number of roentgens by the roentgens per minute, to find the minutes required. The procedure is as follows: From the intersection of the line

CHART FOR DETERMINING

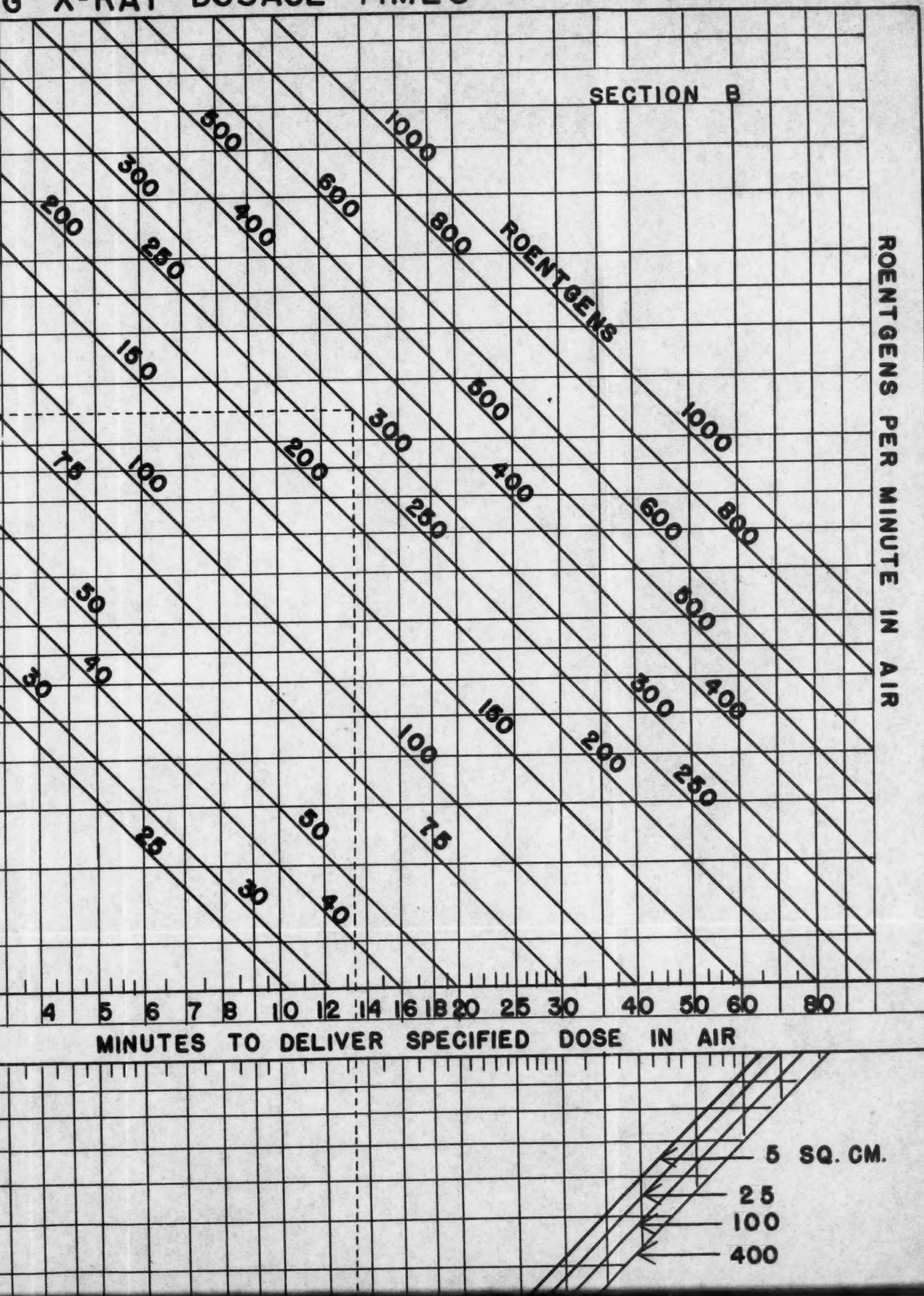


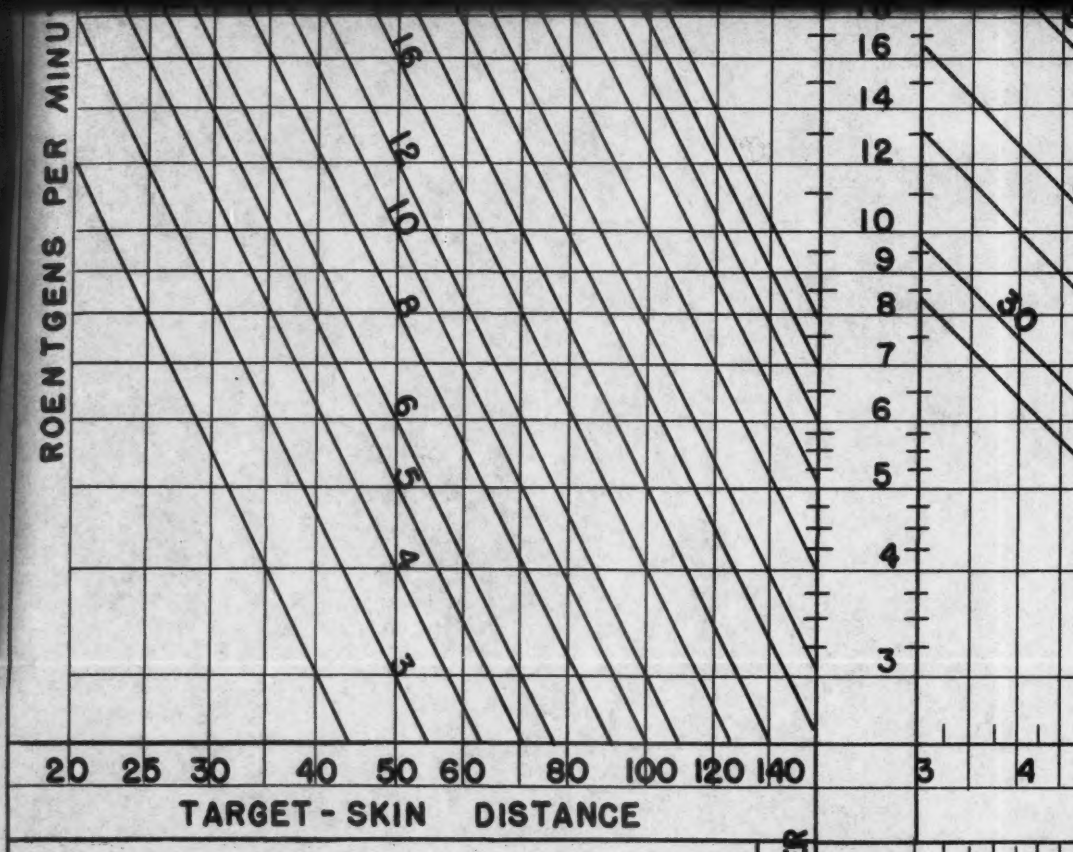
EXAMPLE SHOWING METHOD OF USE

CALIBRATION:- 58 R/MIN IN AIR
50 CM. DIST. 200 KV. 0.5 MM. CU. FILT.
H.V.L. 1.0 MM. CU.

REQUIRED:- MINUTES TO DELIVER
300 R ON 100 SQ. CM. FIELD AT 80

G X-RAY DOSAGE TIMES





EXAMPLE SHOWING METHOD OF USE

CALIBRATION:- 58 R/MIN IN AIR 50 CM. DIST. 200 KV. 0.5 MM. CU. FILT. H.V.L. 1.0 MM. CU.

REQUIRED:- MINUTES TO DELIVER 300 R ON 100 SQ. CM. FIELD AT 80 CM., INCLUDING BACK SCATTER.

FOLLOW DOTTED LINE.

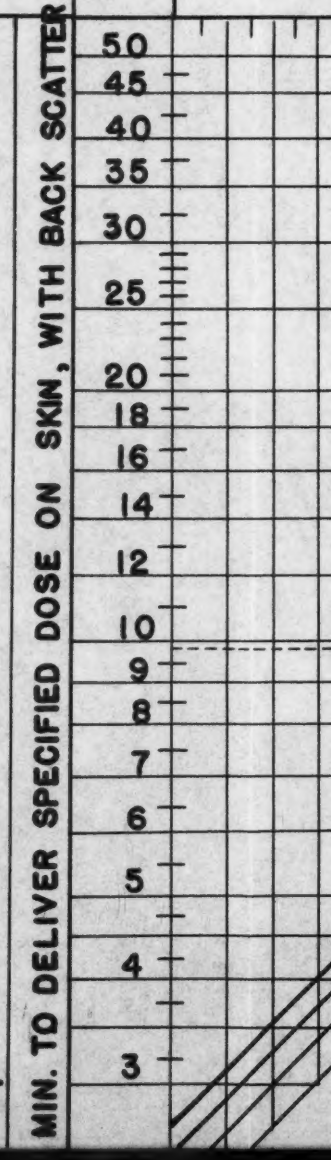
1. IN SEC. A, ON VERTICAL LINE FOR 50 CM. DIST. FIND POINT FOR 58 R/MIN.

2. FOLLOW DOWN OBLIQUE LINE TO 80 CM. DIST.

3. FOLLOW HORIZONTAL LINE ACROSS INTO SEC. B, TO INTERSECTION WITH OBLIQUE LINE FOR 300 R.

4. FOLLOW VERTICAL LINE DOWN INTO SEC. C, TO INTERSECTION WITH OBLIQUE LINE FOR 100 SQ. CM.

5. FOLLOW HORIZONTAL LINE TO LEFT MARGIN OF SEC. C; THE NUMBER FOUND HERE INDICATES THE TIME REQUIRED FOR THE TREATMENT OUTLINED ABOVE, - 9.8 MIN.



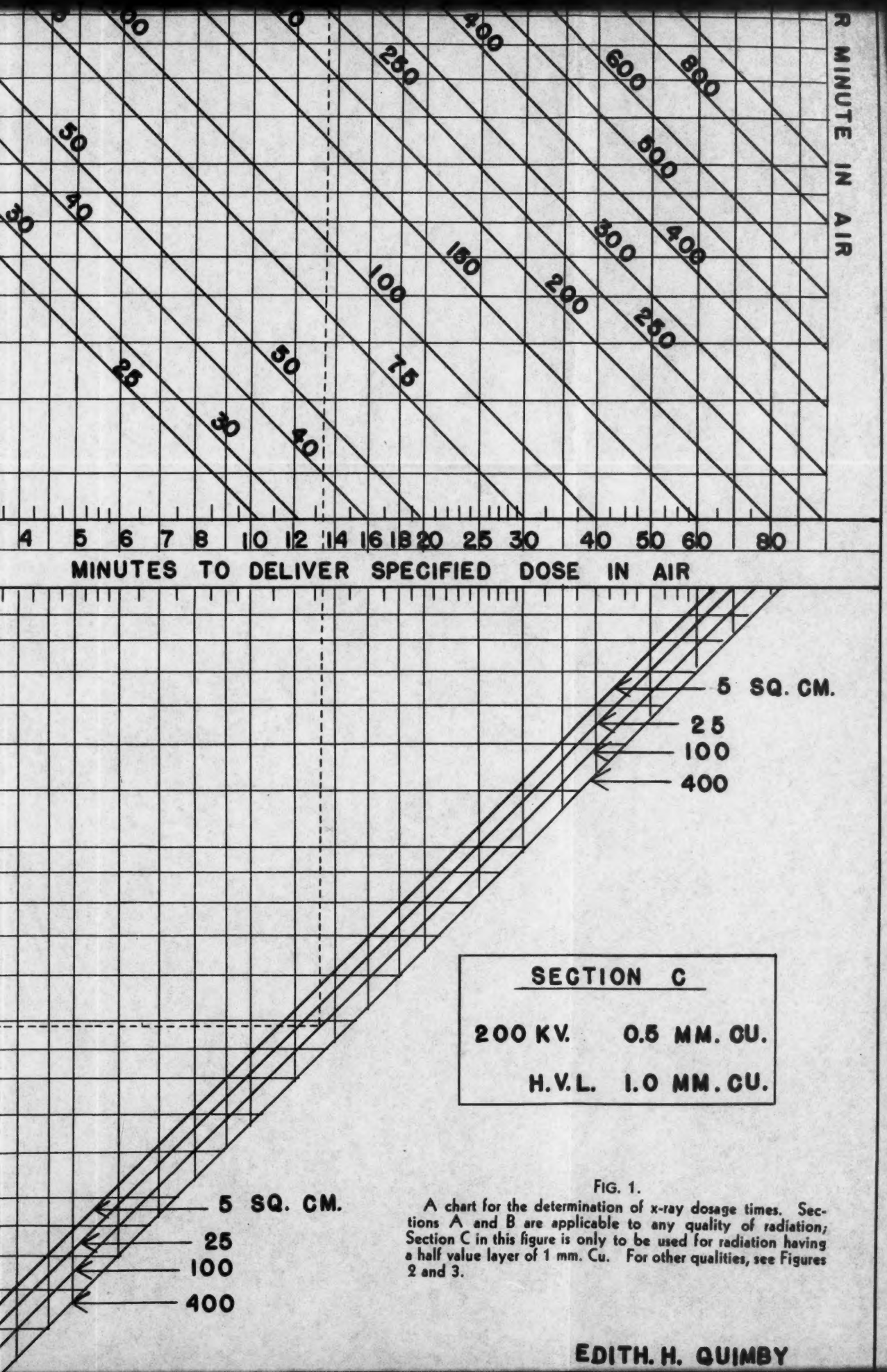


FIG. 1.

A chart for the determination of x-ray dosage times. Sections A and B are applicable to any quality of radiation; Section C in this figure is only to be used for radiation having a half value layer of 1 mm. Cu. For other qualities, see Figures 2 and 3.

EDITH. H. QUIMBY

for the correct r per minute at the distance used, and the oblique line for the number of roentgens to be given, follow a vertical line down to the scale at the bottom of the section. On this is read the time for the required dose, in air. For example, at 35 r per minute, 250 r are delivered in 7.2 minutes.

Section C consists of a third set of parallel straight lines, which provide for the determination of the time required to deliver a specified dose on a particular skin field when the time for the dose in air is known. The operation here performed is the division of the time for the air dose by the back-scatter factor, to give the time for the skin dose. The procedure is similar to that outlined for the operation of Section B. For example, if 500 r are delivered in 25 minutes in air, they will be delivered in 18.4 minutes on a 100 sq. cm. field, with the quality of radiation specified on Section C.

None of the individual operations just mentioned is difficult; the construction of such a chart would scarcely be warranted if each one had to be performed separately. The advantage is that the final answer to the dosage problem may be obtained without stopping at any of the intermediate points. The mechanism of applying the chart to such a problem may best be explained by an example. Suppose that a certain x-ray machine has been calibrated and found to deliver 58 r per minute in air, at a distance of 50 cm. It is desired to find the irradiation time necessary to deliver 300 r at the center of a 100 sq. cm. field, using a target-skin distance of 80 cm. The following steps are carried out (indicated by a dotted line on the chart):

1. In Section A, at 50 cm. distance, find the line nearest to 58 r per minute, in this case, at 60 r per minute. The value for 58 r per minute is interpolated as indicated.

2. Follow the interpolated oblique line to the 80 cm. distance.

3. From the intersection of the interpolated line and the 80 cm. line, follow a horizontal line across into Section B. (The point where this line crosses the scale between the sections A and B gives the r per minute at 80 cm., namely, 22.6, but it is not necessary to read this value unless it is desired to record it.) Continue this horizontal line in Section B until it meets the line for the required number of roentgens, in this case, 300.

4. At this point of intersection, turn and follow a vertical line down into Section C. (The point where this vertical line crosses the scale between the sections B and C gives the time for the delivery of the required number of roentgens in air, 13.2 minutes. However it is not necessary to read this unless this information is specifically required.) Continue this vertical line on in Section C until it meets the oblique line for the specified size of field; in this case, 100 sq. cm.

5. At this point of intersection, turn and follow a horizontal line to the scale at the left of Section C. The intersection of this line with the scale gives the time required; in this case, 9.8 minutes.

This process may be carried out in much less time than is required to describe it. It takes the place of the following arithmetical operations:

1. Inverse square law calculation for r per minute at 80 cm.:

$$58 \times \frac{(50)^2}{(80)^2} = 22.6.$$

2. Calculation for 300 r in air:

$$\frac{300}{22.6} = 13.2$$

3. Calculation of the back-scatter allowance for the dose on the field. This involves a knowledge of the back-scatter factors (see below). The factor required in this case is 0.74.

$$13.2 \times 0.74 = 9.8.$$

These operations involve no difficult mathematics, but they require more time than the operation of the chart, and afford opportunities for error at each step.

Sections A and B are applicable to any quality of radiation. For a particular installation, they can be used for any dis-

tance within which the inverse square law has been found to hold. Section C is applicable to only one quality of radiation. It is possible to have as many such sections C as desired, for various qualities; these can be attached below Section B as desired. Figure 2 gives sections C for two softer radiations than that in Figure 1, and Figure 3 for two harder qualities. The five sections C thus available cover a range of qualities from half value layer 0.2 mm. Cu to half value layer 2.0 mm. Cu. For any quality within this range but not exactly the same as any of the charts, it is satisfactory to use the one nearest to it. Any error thus introduced will be less than 5 per cent. The back-scatter factors used in the construction of these charts are those obtained at the Memorial Hospital by means of the extrapolation ionization chamber (1, 2).

Certain limitations to the application of Section C should be noted. Although the field sizes are given in square centimeters, it should be mentioned that these back-scatter factors are not applicable to fields of the given area but of extremely elongated shape. The data were determined for square fields. Previous investigations have shown that approximately the same values would be obtained for circular, rectangular, or irregular fields, as long as one dimension was not more than twice the other. For fields of a given width, the back-scatter is not substantially increased by increasing the length to more than twice the width. For instance, the scatter for a field 8 × 40 cm. would not be appreciably more than for one 8 × 20 cm. Hence in calculating for such a field, the figure for the smaller one should be used.

It should further be mentioned that these values for back-scatter are correct only if the part of the body under consideration is thick enough to furnish the maximum back-scatter. This is effectively true for thicknesses of about 10 cm. For smaller thicknesses, the times should be increased, as shown in Table I.

It is possible by means of this chart to work out certain subsidiary problems.

TABLE I.—CORRECTION FACTORS FOR THIN PARTS OF THE BODY

Field (sq. cm.)	Thickness of Underlying Tissue (cm.)	Per Cent Increase to Apply to Time as Read from Chart
5	1	10
	2	7
	4	5
	7	2
25	1	15
	2	10
	4	6
	7	3
100	1	20
	2	14
	4	9
	7	5
400	1	27
	2	19
	4	12
	7	6

For instance, to find the number of roentgens delivered on any field in a given time, when the r per minute are known. Start from the given number of minutes on the scale at the left of Section C, follow a horizontal line in this section to the oblique line for the field used. From this intersection, follow up a vertical line into Section B, until it meets the line representing the r per minute. The number of roentgens delivered will be determined by the oblique line at this point. For example, find the number of roentgens delivered on a 100 sq. cm. field in 7 minutes, at 40 r per minute in air. By following the above procedure, starting at 7 minutes on the left-hand scale in Section C, it is found to be almost 400, say 370.

To find the number of roentgens on any field, when the number of roentgens in air is known: Start in Section B from the intersection of the line for r per minute in air for the set-up used and the oblique line for the number of roentgens in air. Follow down a vertical line into Section C, noting the reading on the scale between the two sections. In Section C, extend the vertical line until it meets the oblique line for the field in question. Follow back up along this oblique line until it intersects the horizontal line in Section C for the same num-

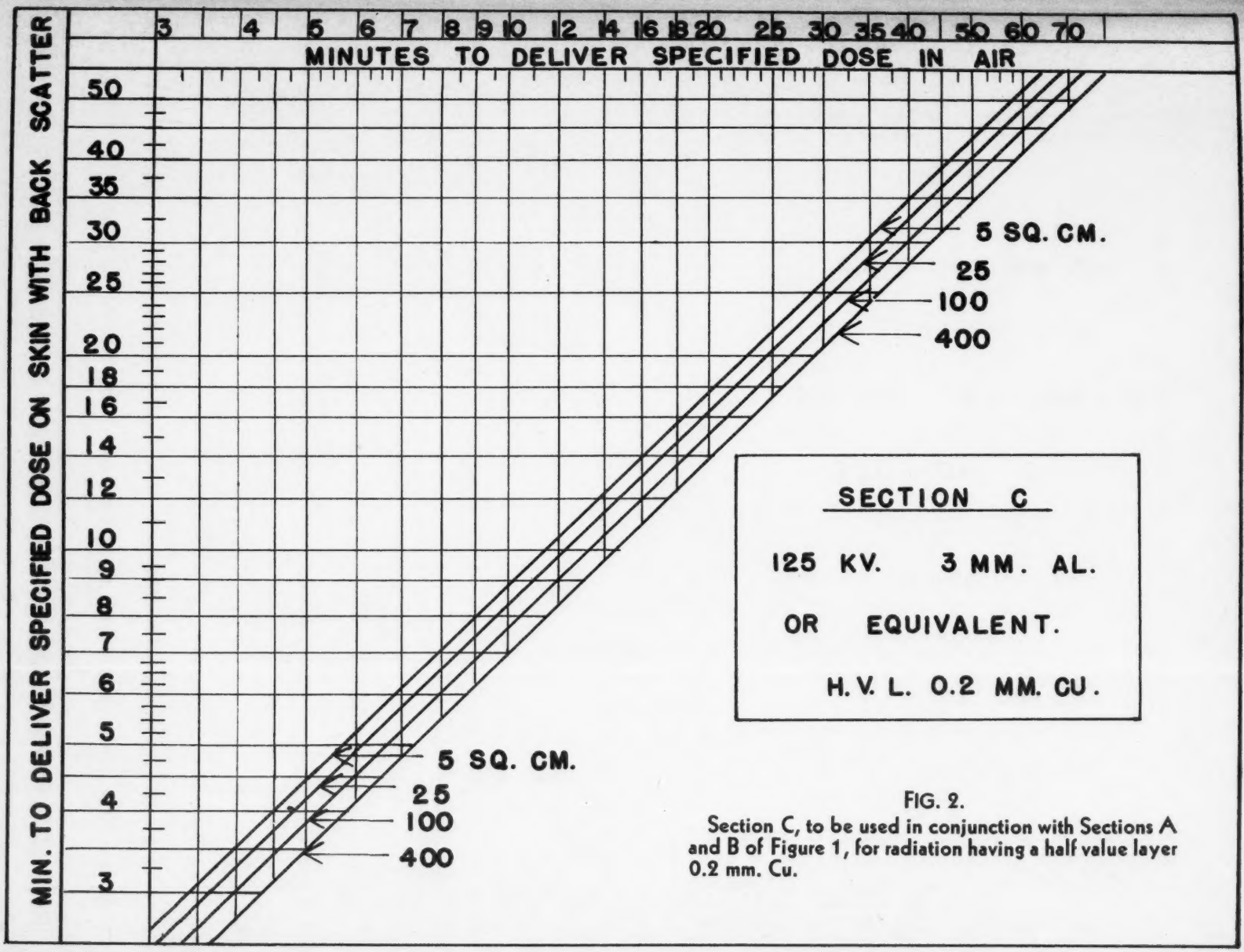


FIG. 2.
Section C, to be used in conjunction with Sections A and B of Figure 1, for radiation having a half value layer 0.2 mm. Cu.

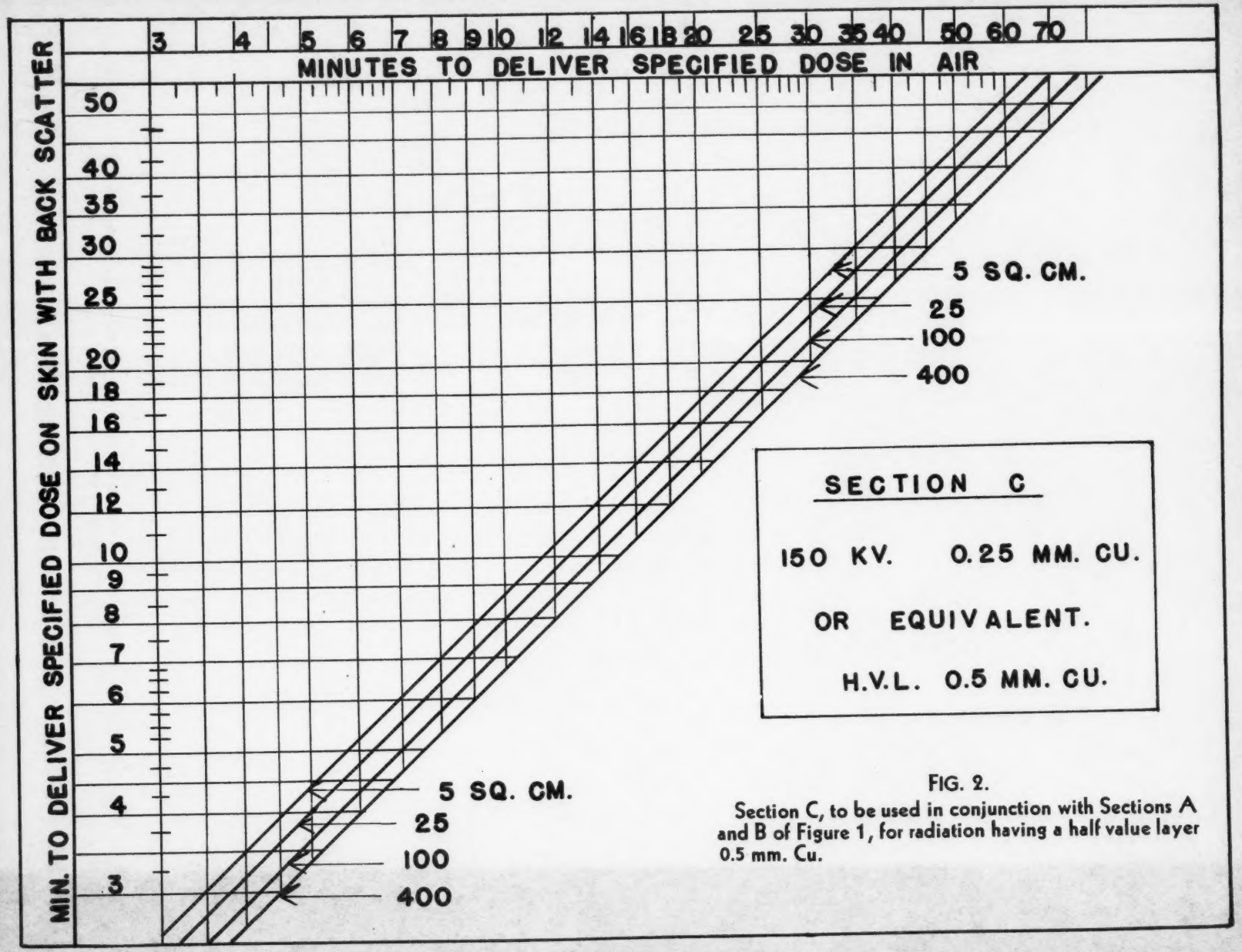


FIG. 2.

Section C, to be used in conjunction with Sections A and B of Figure 1, for radiation having a half value layer 0.5 mm. Cu.

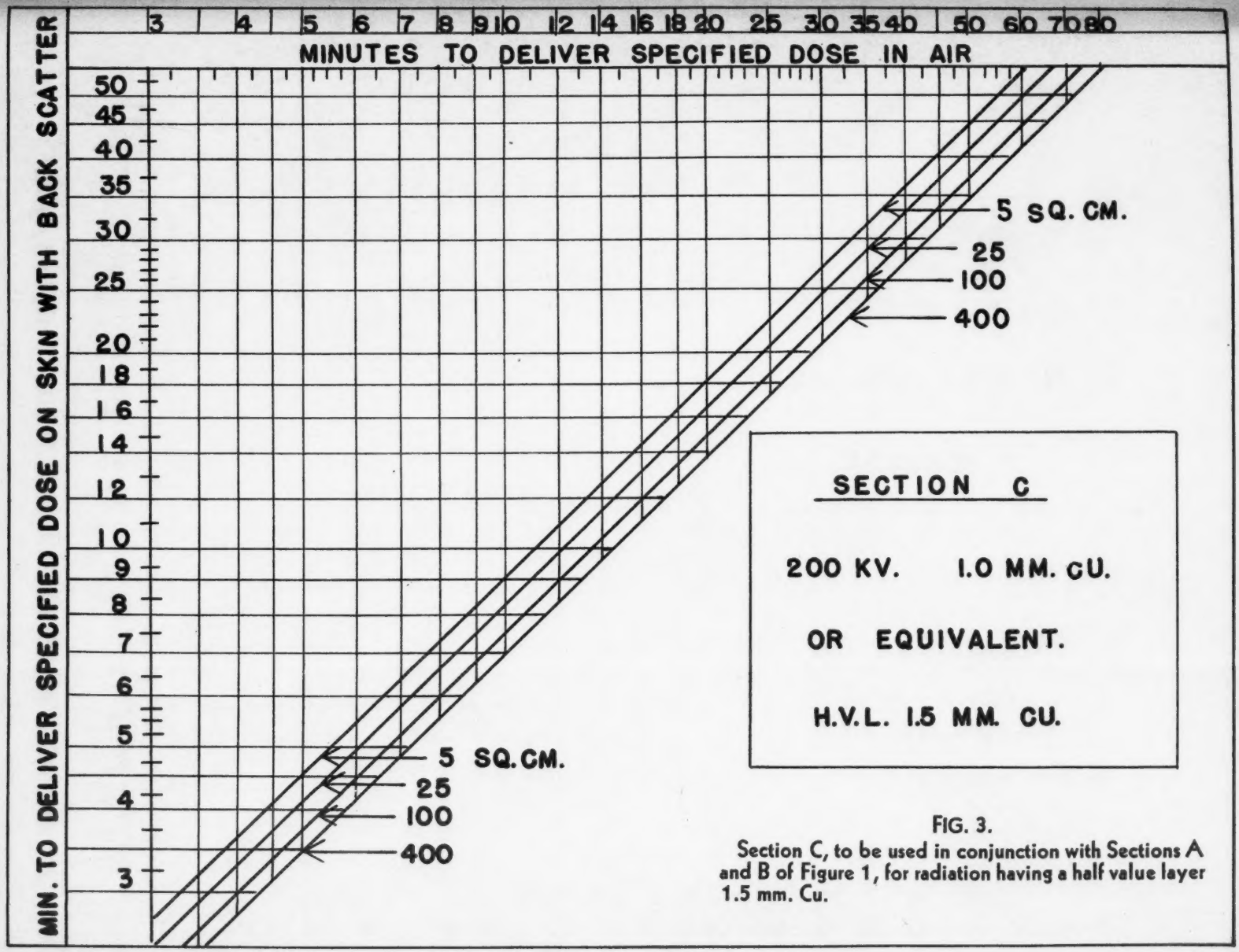


FIG. 3.

Section C, to be used in conjunction with Sections A and B of Figure 1, for radiation having a half value layer 1.5 mm. Cu.

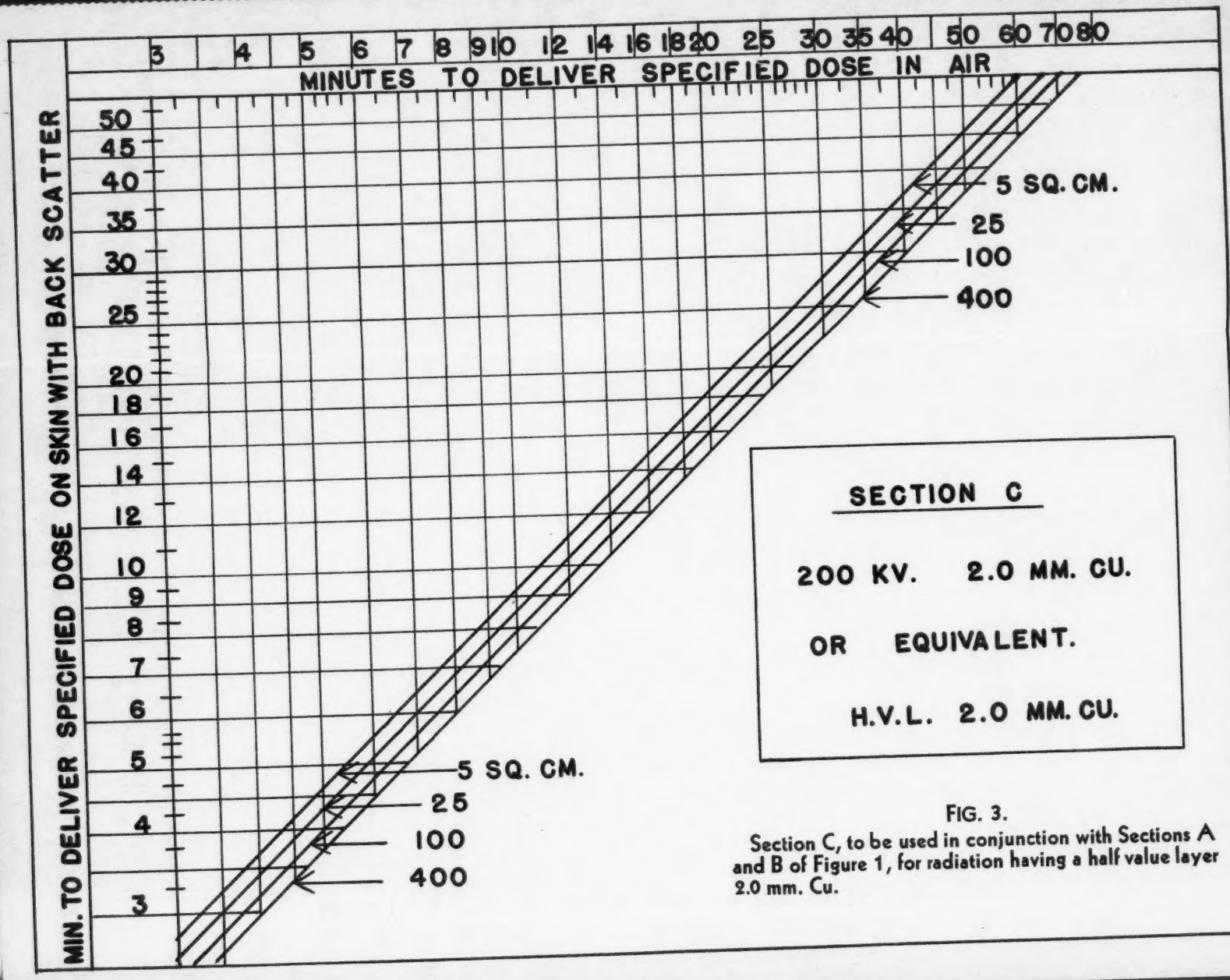


FIG. 3.

Section C, to be used in conjunction with Sections A and B of Figure 1, for radiation having a half value layer 2.0 mm. Cu.

ber of minutes as was read on the scale between the two sections. From this point, return up a vertical line into Section B until the r per minute line is again reached. The oblique line at this point indicates the number of roentgens on the field. For example: find the number of roentgens delivered on a 25 sq. cm. field, for 600 r in air, the output of the tube being 30 r per minute. (The result will be the same whatever the r per minute, but it is necessary to have some definite starting point.) From the intersection of the line for 30 r per minute and the one for 600 r, a vertical line cuts the intermediate scale at 20 minutes. Continue to follow this vertical line into Section C, to its intersection with the oblique line for 25 sq. cm., then go back along this oblique line until it meets the horizontal line for 20 minutes. From this point, return up a vertical line into Section B, until it meets the 30 r per minute line again. This point falls between the 600 and 800 r lines, about three-fourths of the way to 800, indicating a dose of 750 r.

The range of values provided in each section of the chart should be ample for most practical purposes. Interpolation between the given lines in any section is permissible. The need for such interpolation will probably be frequent in Sections A and C. The r per minute found by calibration is seldom one of the numbers defining a line. However, the correct value for the calibration, at the distance used, can be found on the scale at the right of the section, and the interpolation performed as indicated in the detailed example illustrating the use of the chart. In Section C it seemed advisable to draw lines for only a few fields, because they fall so close together. The insertion of intermediate ones would probably lead to confusion. However, no significant error is introduced by making even fairly rough approximations between those given. For instance, if a 10 sq. cm. field is used, and the time is found for a point about half way between the 5 and 25 sq. cm. lines (perhaps slightly closer to the former), the error will probably not exceed 2 per cent. Similarly a value for 50 sq. cm. can be taken just less than half way between the 25 and 100 sq. cm. lines, and for 200 between 100 and 400. For areas nearer the ones on the chart, allowance can be made accordingly.

It will sometimes happen that parts of the lines necessary for solving a certain problem will be missing. In such cases the result can readily be found for doses ten times as large, or one-tenth as large, as the case may be. For instance, to find the time required to deliver 600 r, at 4.5 r per minute: In Section B, the line for 4.5 r does not intersect the line for 600 r; this intersection would be somewhere off the right margin of the chart. However, the problem can be readily solved for 45 r per minute, and the time obtained for this, multiplied by 10, gives the time for 4.5 r per minute. Again, the chart will not give the time for 100 r at 60 r per minute. It will, however, give the time for 100 r at 6 r per minute and this can be divided by 10. It will also give the time for 1000 r at 60 r per minute, which, divided by 10, will give the same result.

It has been suggested that this chart should be extended so as to give depth doses. A little consideration shows that this is not practicable. Changing the target-skin distance does not alter the relation between air and surface doses, but it does alter the relation between air and depth, or surface and depth doses. Also, of course, the relation between surface and depth doses changes with quality of radiation, as well as with size of field. A complete chart would have to be made for every distance and for every depth desired, for each quality of radiation to be used. It is obviously much simpler to obtain the relation between surface and depth doses from tables. The chart is not intended to replace dosage or back-scatter tables, but to serve as a practical tool.

REFERENCES

(1) FAILLA, G.: The Measurement of Tissue Dose in Terms of the Same Unit for All Ionizing Radiations. RADIOLOGY, **29**, 202–215, 1937.

(2) QUIMBY, EDITH H., MARINELLI, L. D., and FARROW, J. H.: A Study of Back-scatter. Am. Jour. Roentgenol. and Rad. Ther., **39**, 799–816, 1938.

THE EFFECT OF FILTRATION ON DIVERGENT BEAMS AT SUPERVOLTAGES[1]

By HENRIETTA S. HAYDEN, PH.D., KENNETH E. CORRIGAN, PH.D., *and* BENEDICT CASSEN, PH.D., *Detroit, Michigan*

IT can be stated as general knowledge that a filter placed in a beam of roentgen radiation may give rise to a heterogeneous beam of quality no better, or perhaps worse, than that of the original beam. A thorough study of this problem in the 200 kv. range was made by the Memorial Hospital group (1).

At 500 kv. it was found in this laboratory several years ago (2) that the interposition of a lead filter in the beam as used for therapy might cause a decrease in the depth dose, while at the same time the beam showed an improved half value layer in aluminum. These phenomena were investigated to try to find a satisfactory filter for 500 kv. therapy. They have been further investigated as to their limits and their basic physical causes.

Experiments were carried out with the presswood phantom, using a series of diaphragms to simulate a therapy cone, and placing filters in the beam at different points between the target and the field. The diaphragms gave the normal cross-section of a therapy cone at all points along the path, without giving the side reflections and scattering of an ordinary lead cone. Figure 1 shows the experimental set-up and gives the designations used for filter positions. Position "zero" was 5.8 cm. from the center of the focal spot, this being the closest possible approach to the target. Position "1" was on the first diaphragm, which is permanently fixed 15 cm. from the focal spot. Positions "2" and

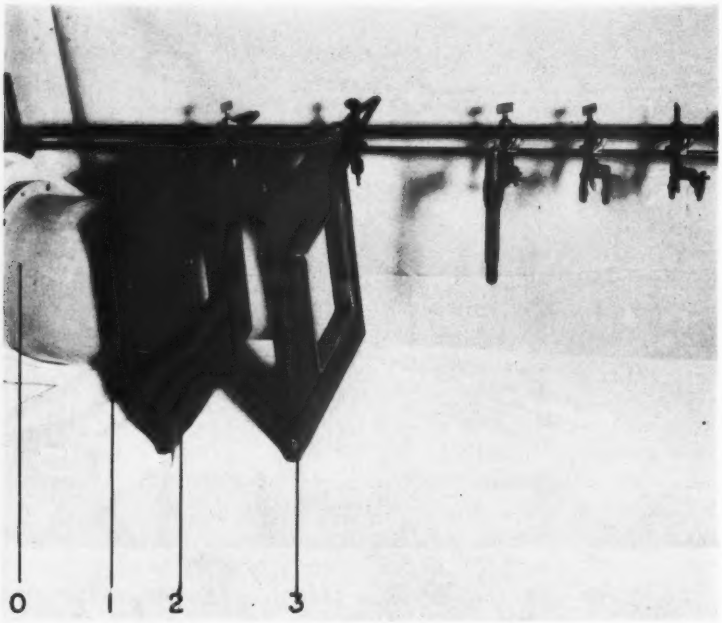


Fig. 1.

[1] Presented before the Fifth International Congress of Radiology, at Chicago, Sept. 13–17, 1937.

"3" were determined as the points at which the 10 and 15 cm. square diaphragms had to be placed to project a 20 × 20 cm. field on the surface of the phantom at 60 cm. These distances were (2) 25.4 cm. and (3) 40.6 cm. The surface of the phantom was protected by a 20 × 20 cm. diaphragm and secondary filters at all times.

TABLE I.—CHANGE IN DEPTH DOSE WITH CHANGE IN FILTER POSITION

(60 cm. distance)

Thickness of Lead Filter	Position of Filter	D_{10}
0.25 mm.	1	48.7
	2	49.1
	3	48.6
0.5 mm.	1	50.0
	2	50.5
	3	49.5
1.1 mm.	1	50.0
	2	49.0
	3	49.1
2.7 mm.	1	49.4
	2	49.9
	3	48.0

Table I shows the tabulated depth dose data. It was found that, in general, a thin filter in position close to the target gave a decrease in depth dose. Some improvement was found with the filter near the phantom. In general, the best results were obtained with the filter near the midpoint along the length of the cone.

Since the depth dose is influenced by two independently variable factors, the quality and the distance, an attempt was made to analyze these separately. The factors varied were (1) the thickness, and (2) the position of the filter. The properties measured were (1) the quality of the resulting beam, (2) the relative quantity of radiation originating from the filter, and (3) the depth dose at 10 cm. in presswood at distances as given.

Several methods of quality measurement were used, of which only one, the half value layer in aluminum, will be discussed. For this purpose a series of thick lead diaphragms 2.5 cm. in diameter were set up so that lead filters could be interposed in the positions given and the measurement made with aluminum filters remote from the measuring chamber. The half value layers found are shown in part in Figure 2. For any one position of the filter the half value layer increases in the normal manner for the thickness of the added lead, but there is also a change depending upon the position of the filter. These data are summarized in Figure 3. Here the thickness of the filter is plotted against the half value layer, and a separate curve drawn for each position. It is seen at once that the quality at any filtration shows an apparent increase as the filter is moved away from the target. Figure 4 shows the geometry of the system in which these half value layers were measured. If we consider the effective size of the filter to be limited by the diaphragm as shown, it can be seen that the filter subtends a definite solid angle to the target at any position. This angle is, then, the total solid angle through which the primary radiation striking the filter may be scattered into the direct beam. The larger this angle, the more radiation may be scattered in, and also since the quality of the scattered radiation is a function of the scattering angle, larger angles will give poorer radiation. It is obvious, then, that if smaller diaphragms had been used different results would have been obtained.

We can consider next the effect of expanding our system to the size of a therapy cone. This was done, and while quality measurements are without meaning on so large a beam, measurements were made to determine the quantity of radiation originating at the filter. This was done by making measurements in free air at two different distances from the target and taking the ratios of the readings. The ratio is the measured intensity at 70 cm. divided by the reading at 60 cm. The theoretical ratio then is equal to 60 squared divided by 70 squared and is the ratio of intensities to be expected from a point focus with no scattering material interposed. This value is 0.735. The actual ratio of intensities found with no filter was 0.733, which is a measurable difference due

to the actual size of the focal spot. From this ratio may be calculated a distance to an imaginary point beyond the target which we may call the "geometric focus." The value of this "geometric focus" lies in the fact that it is the average point from which primary radiation would have to originate to have the same degree of parallelism at the measuring point as the radiation produced by the combination of a focal spot of real dimensions with the addition of a scattering filter which covers a large angle. This, then, gives us a geometric measurement of the angle, from which we can calculate the intensity of the scattered radiation. Table II shows the change in this ratio for three thicknesses of filter added in two positions. It is apparent at once that as the ratio increases, approaching 1.0 as a limit, the beam becomes in effect more parallel; that is, the geometric focus moved farther from the measuring point. Conversely, as the ratio decreases the beam becomes more divergent, the geometric focus moving nearer

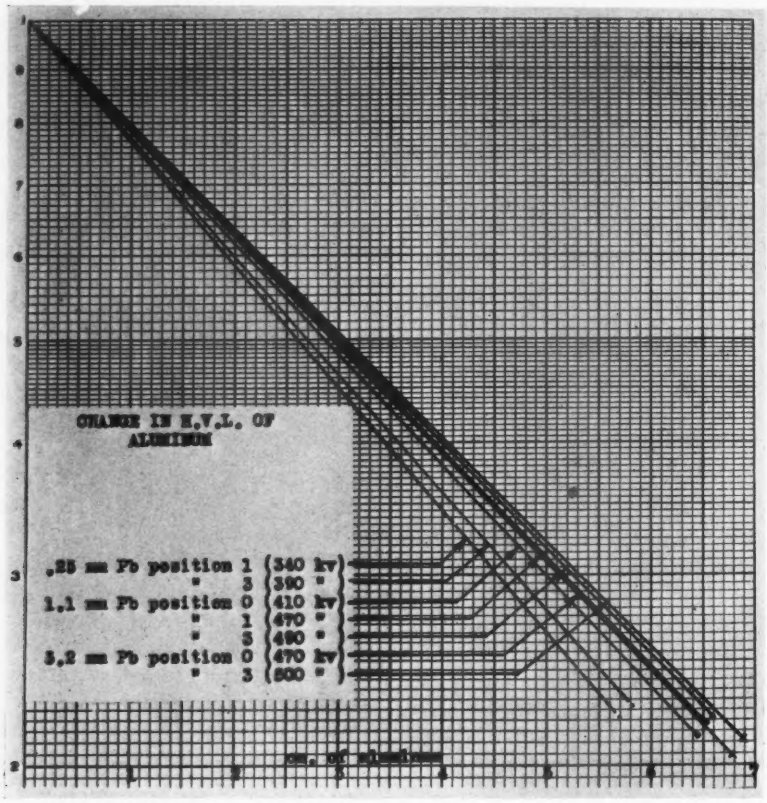


Fig. 2.

TABLE II.—RATIO OF INTENSITIES MEASURED AT 60 AND 70 CM. WITH LEAD FILTERS IN POSITIONS 0 AND 3

Thickness of Lead Filter	Position of Filter	Ratio of Intensities
0.25 mm.	0	0.728
	3	0.716
1.0 mm.	0	0.74
	3	0.683
3.2 mm.	0	0.74
	3	0.713
Calculated value $(\overline{60^2}/\overline{70^2})$		0.735

the measuring point. The intensity of radiation reaching the measuring point is, then, the summation of the radiation originating at the target and at the filter. Since it is not possible to get a unique solution of the equations of intensity with only one ratio for two unknown intensities, three positions of the measuring chamber were used. This gives two independent simultaneous ratios and leads to a solution. The part arising at the target, then, can be calculated in the following manner:

Let x = source strength of focal spot
F = source strength of average filter source at distance d from 28 in. pos.
I = intensity as measured

$$I_{24} = \frac{x}{24^2} + \frac{F}{(d-4)^2} \quad (1)$$

$$I_{28} = \frac{x}{28^2} + \frac{F}{d^2} \quad (2)$$

$$I_{32} = \frac{x}{32^2} + \frac{F}{(d+4)^2} \quad (3)$$

eliminating x between (1) and (2), and between (3) and (2) gives

$$S = \frac{24^2}{28^2}\frac{F}{(d-4)^2} - \frac{F}{d^2} \quad (4)$$

where $S = \frac{24^2}{28^2} I_{24} - I_{28}$

$$T = \frac{32^2}{28^2}\frac{F}{(d+4)^2} - \frac{F}{d^2} \quad (5)$$

where $T = \frac{32^2}{28^2} I_{32} - I_{28}$

eliminating F between (4) and (5) gives

$$S\left(\frac{32^2}{28^2}\frac{1}{(d+4)^2} - \frac{1}{d^2}\right) = T\left(\frac{24^2}{28^2}\frac{1}{(d-4)^2} - \frac{1}{d^2}\right) \quad (6)$$

an equation for d which can be written with negligible error

$$S\left(\frac{32^2}{28^2}\left[1 - \frac{8}{d^2} + \frac{48}{d^2}\right] - 1\right) = T\left(\frac{24^2}{28^2}\left[1 + \frac{8}{d} + \frac{48}{d^2}\right] - 1\right) \quad (7)$$

letting $x = 1/d$, (7) becomes

$$48\left(\frac{32^2}{28^2}\frac{S}{T} - \frac{24^2}{28^2}\right)x^2 - 8\left(\frac{32^2}{28^2}\frac{S}{T} + \frac{24^2}{28^2}\right)x + \frac{S}{T}\left(\frac{32^2}{28^2} - 1\right) - \frac{24^2}{28^2} + 1 = 0$$

which can be solved for x.

Putting solved value of x in (4) gives $\frac{F}{d^2}$, the approximate contribution of the filter at 28 in. position.

The part of the radiation arising at the filter and reaching the measuring point can then be found by difference from the actual measurement. It is shown that this quantity of degraded radiation may be appreciable and that the geometric focus may move a significant distance from the focal spot. The actual findings for the quantity of radiation are shown in Table III.

If now we consider again the geometry of a therapy cone as simulated by a series of diaphragms, shown in Figure 5, it becomes apparent how these phenomena arise. In Position "zero" the filter is illuminated by a cone of radiation far greater in total solid angle than the cone which will eventually reach the field. Since radiation arising from the Compton scattering may pass through an angle of 30° with a loss of only 15 per cent in effective voltage, and since the maximum energy of the Compton scattering at this voltage is confined to a narrow range at an angle of approximately 30° (3), a very large quantity of radiation only partially degraded and still of fairly high quality can be deflected by the filter into the main beam. This phenomenon is influenced by two opposing factors relating to the thickness of the filter. The amount of radiation scattered into the beam is a function of the quantity of material acting as a scattering source, and at the same time the scattered radiation in passing at an angle through the filter must traverse a greater thickness than the primary beam, and is, therefore, more strongly absorbed. The total quantity scattered into the beam will then rise with increase in filter thickness up to a critical point at which the ab-

TABLE III.—CALCULATED INTENSITIES SHOWING RELATIVE AMOUNTS OF RADIATION ARISING FROM THE FOCAL SPOT AND FROM THE FILTER AS SOURCES

Thickness of Filter	Position of Filter	Distance of Chamber from Focal Spot (cm.)		Observed Intensity ($x + F$)	Calculated Intensity (r/m.)		Percentage of Intensity from	
		exp. D	calc. d		main beam x	filter F	main beam	filter
0.25 mm.	0	60	51.2	13.0	7.66	5.34	75.2	24.8
		70	61.2	18.9	15.20	3.70	80.4	19.6
	3	60	54.3	13.29	11.17	2.12	92.0	8.0
		70	64.3	19.0	17.57	1.43	92.5	7.5
1.0 mm.	0	60	67.5	16.47	13.13	3.34	80.0	20.0
		70	77.5	12.15	9.63	2.52	79.0	21.0
	3	60	45.6	16.08	15.12	.96	94.0	6.0
		70	55.6	11.75	11.11	.64	94.5	5.5
3.2 mm.	0	60	54.3	12.7	indeterminate			
		70	64.3	4.64	"			
	3	60	53.8	12.1	"			
		70	63.8	4.35	"			

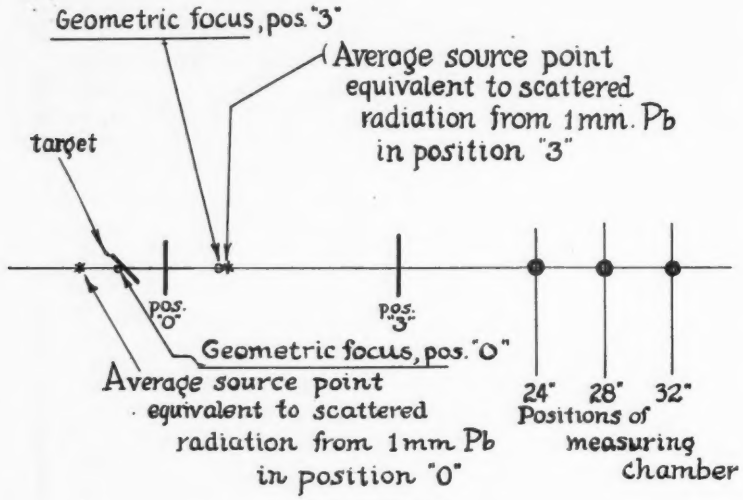


Fig. for Table III.

sorption of the secondary becomes the dominant factor, after which the intensity will begin to fall away. These phenomena are more complicated than this discussion would indicate, and are beyond the scope of this paper.

If the filter is moved to Position "1," the geometric diagram indicates that while it is still exposed to a more extensive angular range than the cone reaching the final field, this range is greatly reduced over Position "zero." The filter then cannot give rise to so much radiation as in its former position, but is itself closer to the measuring point. It is to be expected, then, that as the filter is moved from the target toward the field, the intensity of the scattered radiation from any given thickness of filter, as measured at a fixed point in air or on a therapy field, will fall away at first and then rise slightly. Due to the very large effective area of the filter as a source its measured intensity does not rise rapidly with decreasing distance in this range.

These phenomena are found to hold true on the surface of an actual phantom, as shown in Figure 6. In these experiments

the phantom was at 60 cm. and 80 cm. as shown. The percentage depth dose found is plotted against filter thickness and the

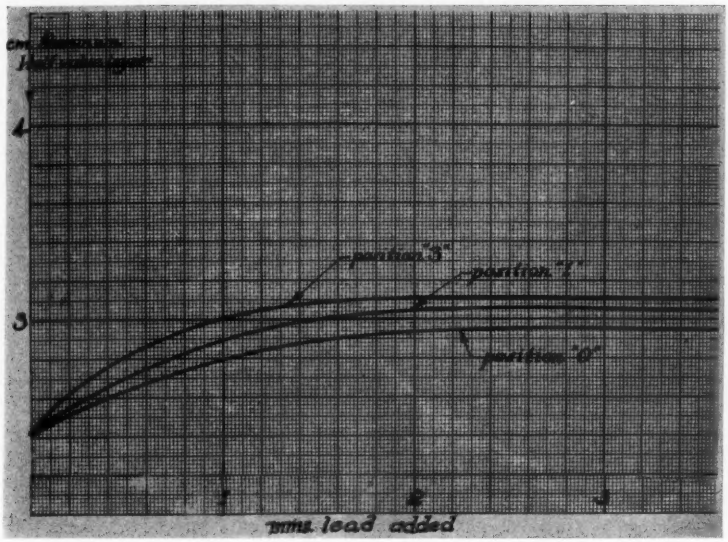


Fig. 3.

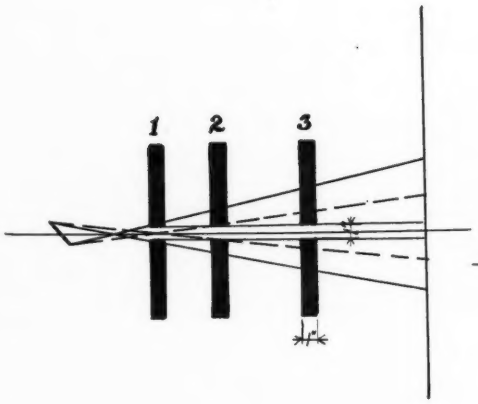


Fig. 4.

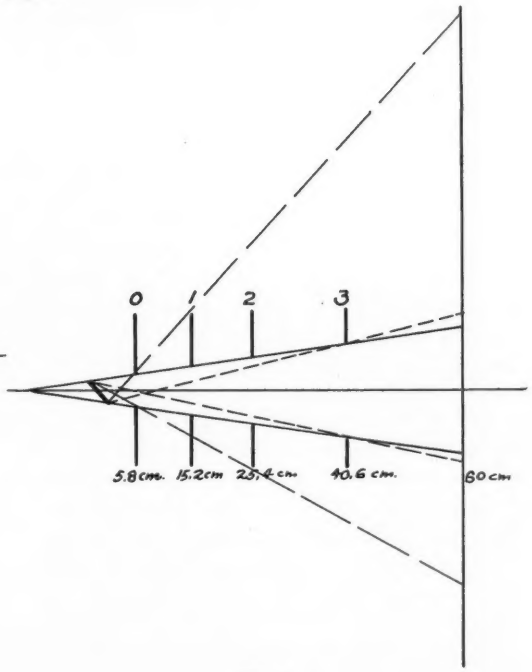


Fig. 5.

curves drawn for each different position of the filter. It can be seen from these curves that a very thin filter in Position "zero," where it is exposed to an extreme intensity of radiation over a very wide angular range, may add a very large factor of degraded radiation to the direct beam and strongly

affect the depth dose. The same thin filter in position close to the phantom where it is irradiated only by the cone of radiation which will reach the field, does not add so much, and further, its component approaches a more nearly parallel distribution, so that while the scattering of degraded radiation is still appreciable, the depth dose is not so strongly affected.

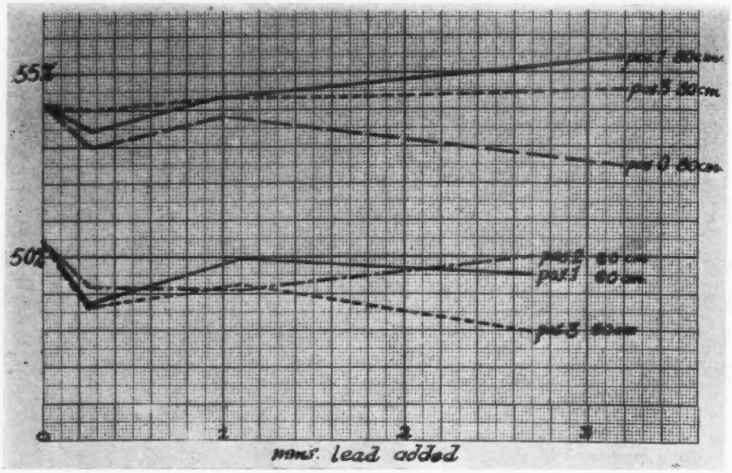


Fig. 6.

For added filter thicknesses which are normal to this voltage, the best effect is found with the filter in some position near the mid-point of the cone, where the filter is irradiated by a cone of radiation only slightly larger than that which will reach the field, and is still at an appreciable distance from the field.

It is to be noted that all measurements reported were taken on the 500 kv. tube, with a beam emergent at zero degrees to the tube axis, and with the surface of the phantom protected at all times with a composite secondary filter consisting of 1.0 mm. Cu, 2.0 mm. Al, and 3.0 mm. celluloid, so that the effect of the soft scattered radiation and the transmission radiation of the lead can be neglected.

SUMMARY

It has been demonstrated—

1. That an added filter in a beam of supervoltage radiation adds a component of hard scattered radiation to the beam.

2. That the quantity of scattered radiation added is significant.

3. That the quality of the resulting beam varies with the thickness of the filter, and may be degraded rather than improved.

4. That the quality of the resulting beam varies with the position of the filter.

5. That improper choice of thickness and position of the filter may give a greatly decreased depth dose.

REFERENCES

(1) Quimby, Edith H.: Measuring Roentgen-ray Quality for Therapy. Am. Jour. Roentgenol. and Rad. Ther., **21,** 64–72, 1929.

(2) Corrigan, K. E.: Comparison of the Effect of Various Filters in the 500 kv. Range. Am. Jour. Roentgenol. and Rad. Ther., **37,** 520–528, 1937.

(3) Cassen, Benedict, Corrigan, Kenneth E., and Hayden, Henrietta: Attenuation and Transition Effects in the Absorption of Supervoltage Radiation. Radiology, page 319 of this issue.

ATTENUATION AND TRANSITION EFFECTS IN THE ABSORPTION OF SUPERVOLTAGE RADIATION[1]

By BENEDICT CASSEN, PH.D., KENNETH E. CORRIGAN, PH.D., *and* HENRIETTA S. HAYDEN, PH.D., *Detroit, Michigan*

From Harper Hospital

THE purpose of this paper is to show that by means of a simple analysis of phenomena of scattering of supervoltage radiation in an absorbing medium it is possible to compute, for practical purposes, the distribution of secondary radiation in the absorber, derive the way in which the total radiation is attenuated, and compute depth doses which agree well with available measurements. The basic nature of the theoretical analysis and the good agreement of the results with measurements gives one confidence in using the results to predict effects that have not yet been studied experimentally.

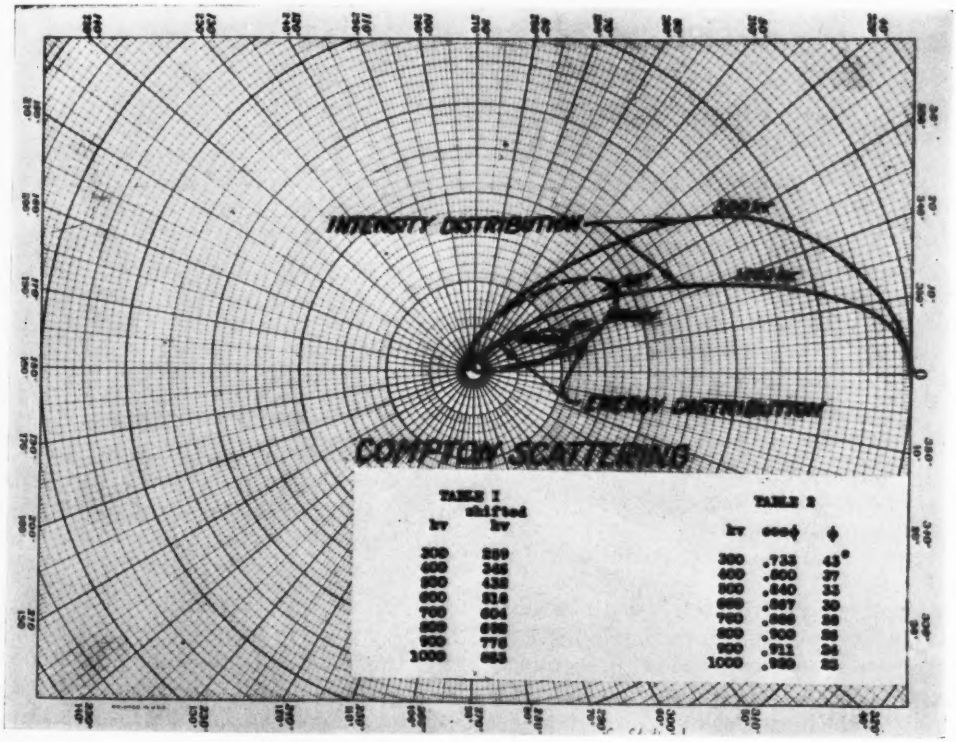


Fig. 1.

The absorption phenomenon of a small beam of roentgen radiation is well known. The absorption coefficients for monochromatic radiation are known for all substances and all voltages attainable. They are used to determine the equivalent voltage of heterogeneous radiation. However, many practical problems involve the use of

[1] Presented before the Fifth International Congress of Radiology, at Chicago, Sept. 13–17, 1937.

large beams in instances in which a large part of the scattered radiation is added to the beam. This is the case in administering depth doses, in filtering large beams, and in the use of protection materials. Fortunately, in the so-called supervoltage range, a simple theoretical analysis can be made which enables the elucidation and quantitative prediction of large beam absorption phenomena valid in the range from about 300 kv. to 1,000 kv. equivalent voltage. This is possible because in this range the bulk of the Compton scattered radiation is scattered in the forward direction to the primary with a maximum at about an angle of ϕ such that Cos ϕ = 1 − 80/kv. and is only softened 14 per cent in equivalent voltage at this angle. Figure 1 shows the angular distribution of the intensity and total energy of Compton scattered radiation at 500 kv. and 1,000 kv. The formula for the cosine of the maximum angle of the energy distribution is really $2\pi(1 - \cos\phi) = 1/\alpha$, where α is the energy of the quantum in mc^2 units. It follows from a general principle of quantum theory which we cannot go into here. The wave length shift at this angle ϕ is 0.0241 $(1 - \cos\phi)$. The shifted value α_ϕ of α at this angle then comes out to be $\alpha\phi = 0.863\alpha$. In other words, the equivalent voltage at ϕ is 86.3 per cent of that of the original and this holds at all voltages. Figure 1 also shows the shifted voltages for each value of primary voltage from 300 kv. to 1,000 kv. This chart shows that the energy maximum is sharp enough to say for practical purposes that all the

TRANSITION EFFECTS

I = intensity of primary at depth X in absorber
I_o = initial intensity
S = intensity of secondary at depth X
a = proportion of removed part of primary beam scattered forward
μ = absorption coefficient of primary
μ_s = " " " secondary (effective)
$d_{\frac{1}{2}}$ = half layer value for primary
$t_{\frac{1}{2}}$ = transition half layer = depth in absorber where S/I is half its equilibrium value

FUNDAMENTAL RELATIONSHIPS

$$dI = -\mu dx \quad , \quad I = I_o e^{-\mu x}$$

$$dS = -a\,dI - \mu_s dx = (a\mu I - \mu_s S)dx$$

or satisfies differential equation

$$\frac{dS}{dx} = a\mu I_o e^{-\mu x} - \mu_s S$$

The solution, satisfying boundary conditions $S = 0$ at $x = 0$, is

$$S = \frac{a\mu I_o}{\mu_s - \mu}\left(e^{-\mu x} - e^{-\mu_s x}\right)$$

then

$$\frac{S}{I} = \frac{a\mu}{\mu_s - \mu}\left(e^{-\mu x} - e^{-\mu_s x}\right) = \frac{a t_{\frac{1}{2}}}{d_{\frac{1}{2}}}\left(1 - e^{-\frac{.693}{t_{\frac{1}{2}}} x}\right)$$

where

$$t_{\frac{1}{2}} = \frac{.693}{\mu_s - \mu}$$

At $x = t_{\frac{1}{2}}$, $(S/I)_{t_{\frac{1}{2}}} = \frac{a t_{\frac{1}{2}}}{2 d_{\frac{1}{2}}}$, at equilib. where $x \to \infty$ $(S/I)_\infty$ approaches $\frac{a t_{\frac{1}{2}}}{d_{\frac{1}{2}}}$

At $x = \frac{1}{2} t_{\frac{1}{2}}$, $(S/I)_{\frac{1}{2} t_{\frac{1}{2}}} = .293 \frac{a t_{\frac{1}{2}}}{d_{\frac{1}{2}}}$

At $x = \frac{1}{4} t_{\frac{1}{2}}$, $(S/I)_{\frac{1}{4} t_{\frac{1}{2}}} = .16 \frac{a t_{\frac{1}{2}}}{d_{\frac{1}{2}}}$

Fig. 2.

Compton scattered radiation is scattered at an angle ϕ and softened 13.7 per cent at this angle. The second table in Figure 1 gives the values of ϕ and $\cos\phi$ for various voltages. The equivalent absorption coefficient of the scattered radiation is the true absorption coefficient for the shifted voltage divided by $\cos\phi$, as for a difference in depth, d, in the absorber, the path of the scattered radiation is $d/\cos\phi$.

The distribution of secondary radiation is given by the following formula, shown in Figure 2:

$$S = \frac{\alpha\mu I_0}{\mu_s - \mu}(e^{-\mu x} - e^{-\mu_s x}).$$

The derivation is shown. Here μ is the absorption coefficient of the primary radiation, μ_s the equivalent absorption coefficient of the scattered radiation, I_0 the intensity of the primary at the surface of the absorber, and α is the proportion of the removed part of the primary that is scattered forward. The proportion of the scattered intensity to the primary at any depth is

$$\frac{S}{I} = \frac{\alpha\mu}{\mu_s - \mu}(1 - e^{-(\mu_s - \mu)x}).$$

In equilibrium, that is, for x very large,

$$\left(\frac{S}{I}\right)_{\text{equilib.}} = \frac{\alpha\mu}{\mu_s - \mu} = \frac{\alpha t_{1/2}}{d_{1/2}}$$

where $d_{1/2}$ is the half layer value for the primary and

$$t_{1/2} = .693/(\mu_s - \mu)$$

is what we call the "transition half layer" value and is equal to the depth in the absorber at which the ratio of the secondary

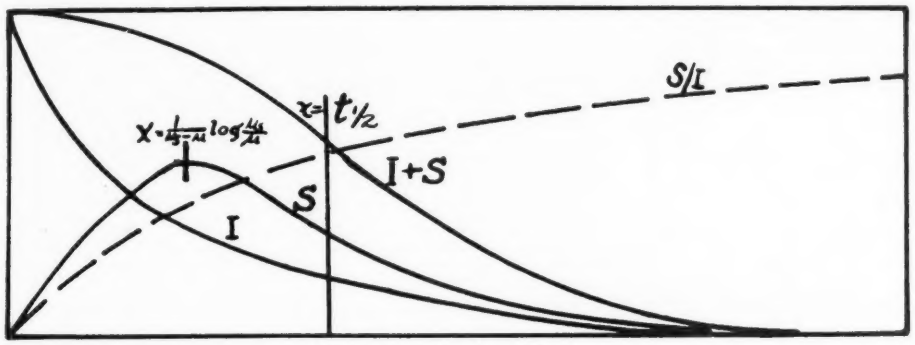


Fig. 2-*A*. Transition effects.

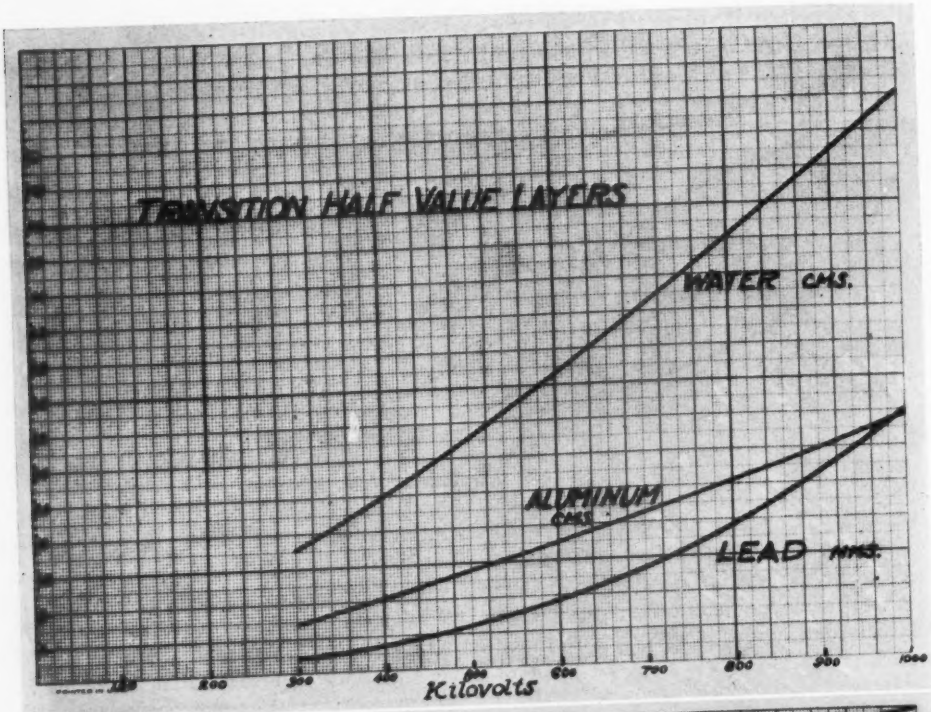
to the primary radiation reaches one-half its equilibrium value.

The curves in Figure 2-*A* show how the primary exponentially decreases, the secondary builds up to a maximum and decreases, while the ratio of the secondary to the primary approaches exponentially a constant value. It can easily be shown that the maximum in the secondary is at a depth $x_{\max}$ such that

$$x_{\max} = \frac{1}{\mu_s - \mu}\log\frac{\mu_s}{\mu}.$$

Figure 3 shows the transition half layers computed for water, aluminum, and lead. Figure 4 shows the equilibrium percentage of secondary to primary for these materials. The curve will be the same for any absorber showing only Compton absorption and scattering.

It can easily be seen that at not too great depths in the absorber the tertiary radiation will not be an appreciable part to the total, so that the practical intensity at small depths is the sum of the primary and the secondary. The attenuation of the sum is not exponential but in low atomic number substances is approximately so, because the absorption coefficients are not sensitive to the voltage. Figure 5 shows, plotted logarithmically, the approximate attenuation curves for water at various voltages compared with the true absorp-



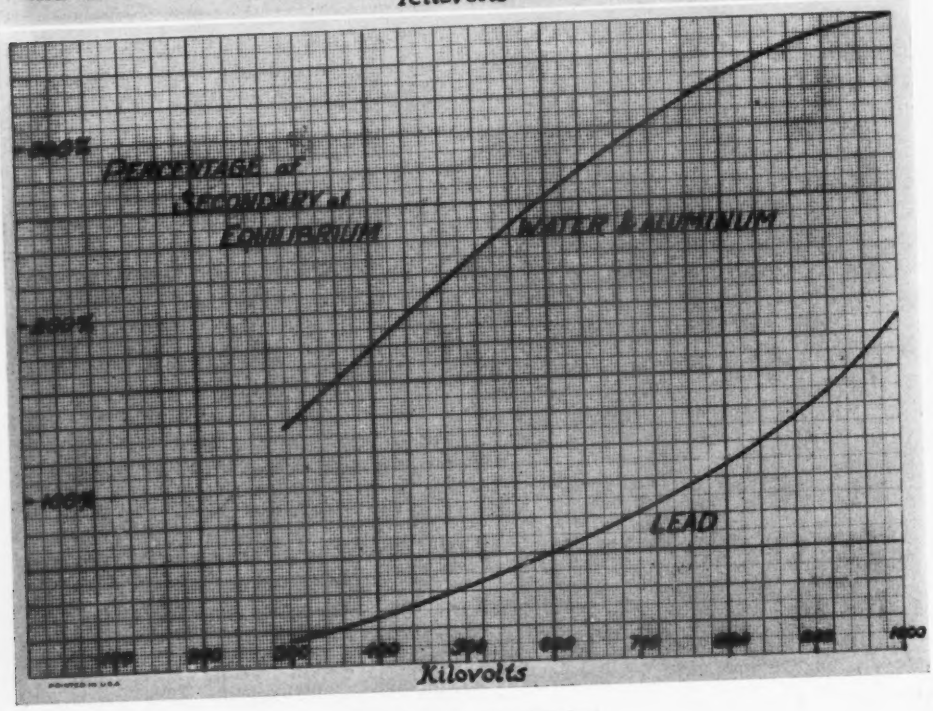
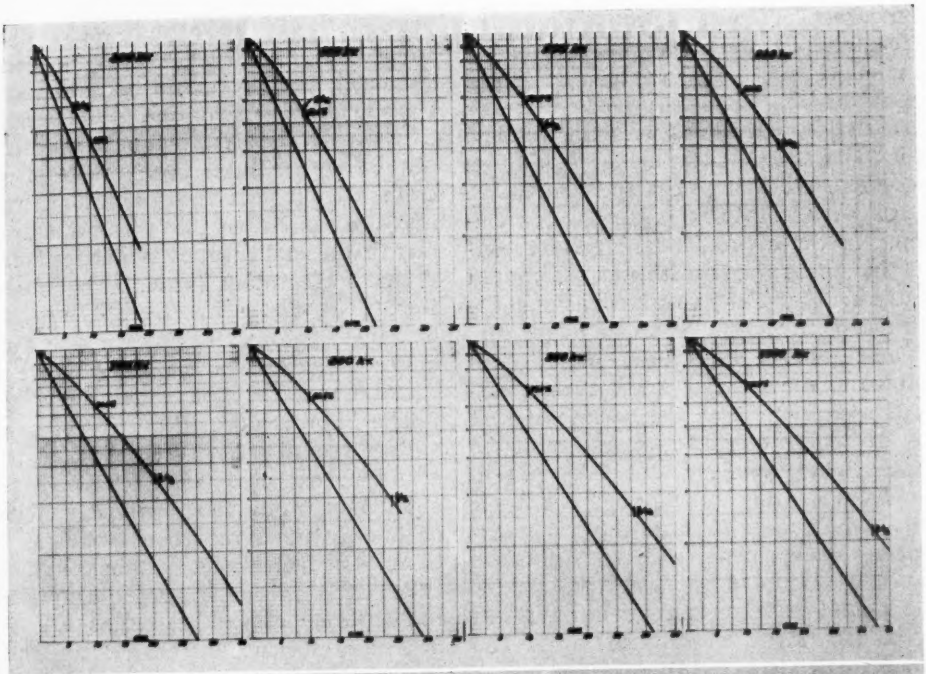


Fig. 3 (*above*). Fig. 4 (*below*).



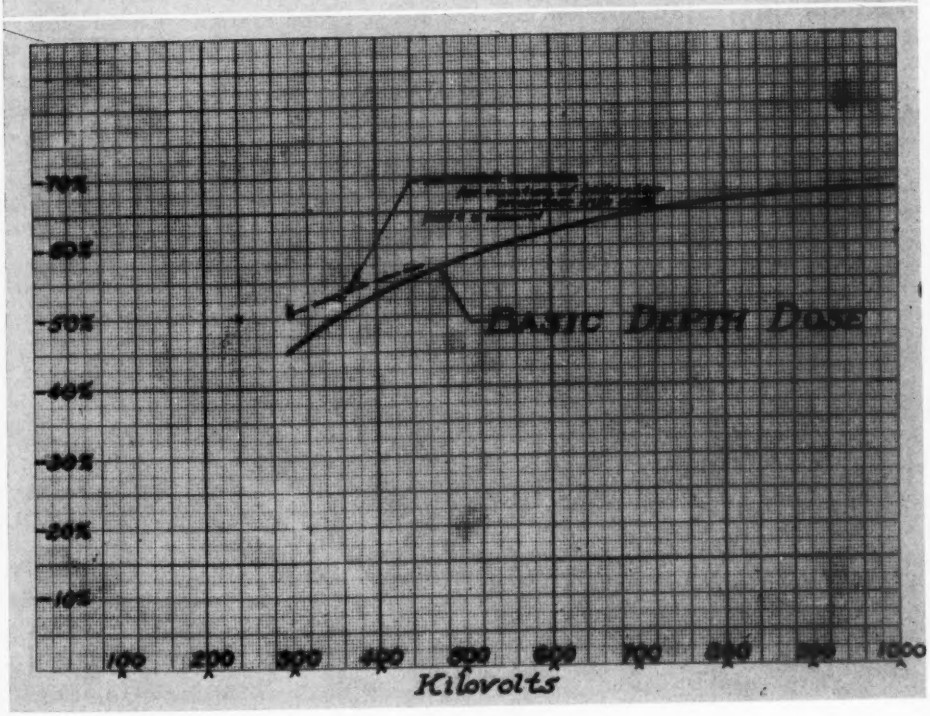


Fig. 5 (*above*). Fig. 6 (*below*).

tion curves. We call, for convenience, the percentage on the approximate attenuation curve at 10 cm. depth, the "basic depth dose." Figure 6 shows how the basic depth dose varies with the voltage. It is well known that in actual depth dose measurements a large contribution to the readings is due to back-scatter of soft radiation. In the approximation we are considering, this back-scatter is Compton scattering of primary and secondary in the backward direction. We can reasonably assume, due to this close similarity in voltage of the primary and forward scattered secondary, that the back-scatter at any depth is a constant percentage of the primary plus secondary at that depth. On the basis of this assumption, the basic depth dose will be the true depth dose except for small tertiary effects. The curve shown in Figure 6 is purely theoretical. The points on it are measurements made in this laboratory several years ago. The curve predicts true depth doses for higher effective voltages than can be obtained at Harper Hospital. It would also be applicable to the depth dose obtainable from a radium bomb at large treatment distances.

Figure 4 shows that in water and aluminum at great depths the secondary intensity can be several times that of the primary. At the higher voltages this would also hold for ordinary concrete. For lead, the maximum of secondary is considerably less than that of the primary. This proves that lead is a better protector against supervoltages than a mass of concrete of equivalent absorption for the primary. It is obvious that this is due to the fact that a smaller proportion in lead of the primary absorption is scattering absorption. The curves in Figure 4 should be of some value in selecting suitable thicknesses of protection in supervoltage installations.

The improvement in quality of supervoltage radiation by filtration is less than would be expected on the basis of true absorption, on account of the degradation of the scattered radiation added to the beam. In fact, under certain conditions, added filter will deteriorate quality. For the filtration of parallel beams lead will be a more efficient filter than a large thickness of lighter material of equivalent true absorption, due to the fact that the lead will add less degraded scattered radiation to the beam. The situation is much more complicated in the filtration of divergent beams.[2]

[2] This subject is treated in more detail in another paper from this laboratory, soon to be published in RADIOLOGY.

X-RAYS AND THE BIOPSITOME IN A STUDY OF THE CORPUS UTERI[1]

By BENJAMIN H. ORNDOFF, M.D., *Chicago*

THE demand of the public for protection against cancer seems to become more urgent year by year. In response to this demand, the medical profession has done much to reveal the mystery of cancer and to control and prevent it. Almost all physicians devote some portion—a goodly number a major portion and a smaller group almost the entire energies of their lives—to the cancer problem. We all recognize that much has been accomplished, but we are deeply conscious of the fact that we cannot hesitate in our vigilance to perfect any measure that may in the slightest way help us to secure further control of cancer. The principal purpose of this paper, therefore, is to emphasize the importance of certain special examinations which may aid in the therapeutic management of cancer and also assist in preventive medical measures.

This discussion presents the clinical applications we have been able to make of x-ray studies of the genital tract after it has been filled with a contrast medium. In conjunction with this, attention is also called to an instrument we have designated a biopsitome. The usefulness of an instrument of this design seems assured. If it were employed more universally, improved designs would be developed, increasing its sphere of application.

X-ray studies are now utilized in almost every division of medical diagnosis, and there are constantly coming to our attention refinements of technic which add new fields in diagnosis. The information obtained in the examination of abdominal viscera, using x-rays and contrast media, has almost revolutionized our methods of determining the presence of pathology in these organs. The safety and the efficiency with which these examinations are conducted and the accuracy of the conclusions drawn from the findings thus obtained need no comment. It should be noted, however, that the high degree of accuracy which has been attained has not been accomplished by a sudden discovery, but rather by the gradual process of evolution arising from technical refinement and perfection of apparatus. Integrating the facts learned by these investigations into clinical medicine has created what appears to be new knowledge of anatomy, physiology, and pathology, which was not well understood until these additional fields of investigation were opened. It has been said that, if the field of usefulness of the x-rays was confined entirely to the examination of the gastro-intestinal tract, it would still remain the most important single agent of science in clinical diagnosis.

The use of x-rays and contrast media in the study of the anatomy, physiology, and pathology of the abdominal viscera preconceives the use of the fluorescent screen, suitably made roentgenograms, and a medium with greater or lesser radiodensity than the organs to be examined. For the investigation of the genital organs and pelvic viscera, a gaseous medium of low radiodensity may be introduced into the peritoneum, such as carbon dioxide, oxygen, or air, and the viscera studied in x-ray films or in the fluorescent screen. This paper, however, is confined almost entirely to the discussion of the work we are doing with x-rays and a contrast medium with a density greater than the organs of the genital tract.

The technical apparatus required for the production of the x-ray films and the fluorescent screen observations include little or nothing that is not in routine use

[1] This paper has been somewhat rearranged for publication but remains essentially as read before the St. Louis Medical Society, Dec. 15, 1936, and the joint meeting of the Philadelphia Roentgen Society and the Gynecological and Obstetrical Society, Feb. 4, 1937.

wherever a radiological practice is being conducted. The difficulties encountered in the technic of introducing a contrast material into the genital tract are few, and likewise require little or nothing with which every physician in active practice is not familiar. The most frequent source of trouble arises in connection with variations of the anatomy which depend upon developmental defects, derangements of inflammatory origin, the presence of neoplastic disorders, etc. The solution of the problems created by these variations requires only the exercise of care and resourcefulness. The most essential requisite, however, is radiological technic.

The contributions to medical literature on the interpretation of the findings in the uterograms, the trachelograms, or the salpingograms seem to be very few when we consider the number of years since this work was introduced into clinical medicine.

Uterosalpingography probably began when Dr. Cary, of Brooklyn, introduced collargol into the cervix, corpus uteri, and oviducts in 1914. My experience began early in 1920 when, with Dr. Emil Beck, we introduced Beck's paste into these organs. Investigations by this method were carried on in a few cases each year, but they did not become a routine measure with us until the more suitable procedure, advocated by Forestier, of France, was adopted. It will be recalled that Forestier delivered lectures on this subject before the radiological bodies of the United States during the Winter of 1925–26. His book, published in English with Sicard, entitled, "The Use of Lipiodol in Diagnosis and Treatment," did much to bring this method of diagnosis into popular use.

The method we use for introducing the contrast material into the cervix and genital organs seems very simple. The apparatus includes a 20 c.c. syringe, a small cannula with end and side fenestrations, a perforated rubber cone, and, occasionally, a single-tooth tenaculum forceps. In addition, we must include a suitable form of vaginal speculum, a vaginal dressing forceps, a uterine probe, sterile cotton, and some suitable antiseptic solution for preparing the vagina before making instrumental introduction through the cervix into the uterus. While the entire procedure is surgical in character, and the preparation of the patient and the instruments are very important, there is nothing required which is not routine in the practice of clinical medicine.

The x-ray equipment may consist of a horizontal fluorescent screen apparatus, which is also adapted to roentgenography, such as is used in regular routine work, but occasionally there are cases in which tilt tables, as well as tables designed for x-ray investigations with the patient in lithotomy, genupectoral, oblique lateral, and other positions are exceedingly helpful. The essential requisites are facilities for conducting roentgenographic and fluorescent screen examinations, while the radiologist institutes certain manipulations of the uterus through the instruments which will bring these organs into proper position for investigation.

Special examinations of this character should not be instituted until the physician has acquainted himself with the history and all of the knowledge available through physical findings. The position, size, shape, the relation of these organs to other viscera in the pelvis, the points of tenderness, and the findings of a careful probe investigation of the cervical canal and uterus should be considered and correlated before x-ray investigations are begun. A gauge to indicate the pressure under which the contrast material is being introduced is not essential. One must develop a knowledge of the feel when pressure is applied to the piston of the syringe, and ranges from 0 up to 200 millimeters of mercury must be learned. This knowledge may be gained in the following manner: Connect a blood pressure manometer to one end of a piece of rubber tubing and close it at the other end with artery forceps. Attach a needle to the syringe used for introducing the contrast material and plunge the needle through the wall of the

rubber tube. Pressure on the piston will be recorded on the manometer.

Before introducing the cannula, the course of the cervical canal should first be explored by the careful use of the uterine probe. The cannula is given the proper curve to conform to the canal of the cervix. When the cannula has been passed through the rubber cone, it is inserted into the cervical canal. The cone is now pushed toward the distal end of the cannula until it rests against the external os. The cannula is clamped with the dressing forceps just proximal to the rubber cone, to secure its position on the cannula when pressure is applied to prevent the return of the contrast material into the vagina. If it becomes necessary, the cer-

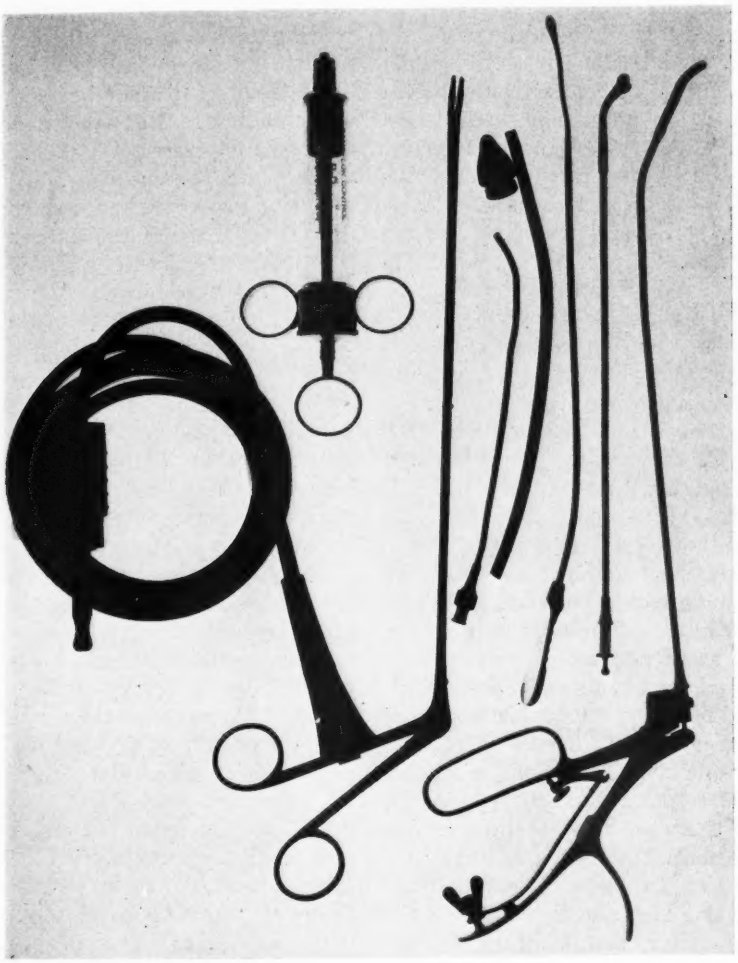


Fig. 1. Illustration shows instruments which have been modified for intra-uterine and deep cervical biopsies, introducing contrast material into the uterus, etc. From above downward is shown a biopsitome, a biopsitome shaft with different end assembly, a flexible uterine probe, a strip of insulating rubber to be used on the shaft of any electrosurgical instrument for intra-uterine work, a rubber cone, an end and side fenestrated flexible cannula, another form of biopsitome assembly with cord attached, and a syringe for introducing contrast material.

vix must be grasped with the curved single-tooth tenaculum and retracted against the rubber cone to prohibit the escape of contrast material from the cervical canal.

The amount of contrast material required depends entirely upon the case. It is necessary to introduce it slowly while making careful fluorescent screen observations. Films for permanent record are made at such intervals as seem advisable. It often becomes advantageous to withdraw a portion in order to outline a defect properly for study and record. Pressure above 100 mm. of mercury is seldom required and should be applied with caution. Manipulations through the instruments will usually change the position of the organs and bring all of the margins and surfaces into position where they may be observed and recorded for further study. In such cases it is necessary to rotate the patient into different positions.

Data obtained by a careful study of the contrast media in the cavity of the corpus uteri with x-rays in conjunction with other clinical findings opens a comparatively new field in medicine. We must first recognize the normal uterogram before we can hope to understand the significance of the various filling defects. It appears that, from uterograms made with a fixed technic in all cases using one or two positions, a reliable diagnosis of a normal uterus cannot be made. Furthermore, the findings which constitute a normal uterogram must take into consideration, the age and the functional state of the endometrium at the time of the examination. For example, a uterus may show the defect which is suggestive or typical of the hypertrophic phase of the endometrium in the active menstrual state. This finding may possess only physiological significance. If recheck examinations show that this mucosal pattern continues to exist through that period in the menstrual cycle when it may be expected to be more quiescent, or more especially if it be near the termination or following the child-bearing period when we would ordinarily find evidence of atrophy, then these findings take on greater significance and often become exceedingly important clinically.

Other types of filling defects, which depend upon anatomical derangement, caused by surgical manipulations, childbearing, inflammatory processes, etc., furnish a lucrative field for investigation. These findings cannot be secured by any other method. Still other types of filling defects are presented for study, namely, those of neoplastic origin. In the beginning, it was deemed enough to be able to differentiate the inflammatory from neoplastic defects, but our field has already passed far beyond. It does not appear that the full significance of these findings can be interpreted from uterograms, nor from the combination of uterograms and fluorescent screen findings. I have endeavored to show that our best results are obtained when these findings are correlated with the findings obtained by palpation, inspection, and a consideration of the history and all of the clinical findings.

So long as women continue to be satisfied that they do not require any sort of medical attention until they possess severe pains, develop a noxious odor, have a profuse or bloody discharge, or some other outstanding symptom, they will not seek periodic examinations, and we will not be able to do much in detecting the presence of important pathology early. On the other hand, we must not forget that many women give reports of great dissatisfaction after consulting their physicians. They frequently state that the examinations are very inadequate. It appears that only a brief history and a routine physical examination is not uncommon, and many times inspection of the cervix and probe diagnosis of the cervical canal and uterus is entirely omitted. With meager data, the physician errs by giving assurance that all is well. Later, and too often within a very short time, the patient returns to the same physician with some additional symptoms, and following another examination is informed that something has developed and has already passed beyond the stage in which it may be controlled. This

situation constitutes a real challenge to the profession. Before more refined methods of investigation of the genital organs were available, medical men had some grounds for being excused, but to-day responsibility cannot be shifted. The physician who inspires the woman to think all is safe in this field, assumes a very great responsibility and should do so only when he has available for consideration all of the diagnostic data that can be elicited.

Fig. 2.

Fig. 3.

Fig. 2. This uterogram represents a normal multiparous uterus. This position shows the three margins with the cervical canal and the oviducts. The external os is indicated by the apex of the rubber cone, the internal os is also clearly defined by the uterine triangle. Manipulations through the instruments would bring into view the anterior and posterior surfaces of the uterogram.

Fig. 3. Bicornate uterus. A pocket occurs along the cervical canal near the external os, which can also be detected by careful probe diagnosis. Irregular mucosal pattern is noted at different points in the uterogram. Ostia abdominale are patulent and the oviducts normal.

Careful x-ray examinations of the endometrium will show very minute changes. It remains, however, for us to determine by the microscope the true cytological character of the tissues responsible for the findings elicited by the x-rays. Before 1923, we depended upon tissues removed with the curet for the pathological report. Curettage for diagnostic purposes where malignancy may be present, even when conducted under most skillful surgical technic, has proven dangerous to a point that warrants its abandonment altogether. This problem was brought to my attention very forcefully when two cases, following cervical canal. When the curet was excluded, the handicap in clinical diagnosis became very apparent. The effort to determine the true significance of the fluorescent screen findings and filling defects recorded in uterograms appeared almost hopeless until it became possible to interpret these findings in the light of the pathologic report. Since the correlating studies of this character have extended over a large group of cases, the interpretation of the x-ray findings have become more accurate and reliable.

The solution of the problems of diagnostic curettage was undertaken through electrosurgery. At first we were able to obtain a biopsy specimen by loop resection from the cervix and the cervical canal, and

to correct the pathological processes by electrocoagulation. Later, the deeper cervical canal and endometrium were explored with various types of instruments, and biopsy specimens taken. A practicable technic, however, was not found until we had a contrast medium of suitable composition by which minute filling defects could be observed and located with radiopaque instruments directed to the site of the filling defect. It remained for us to develop an instrument by which a biopsy specimen could be obtained from any given site in the uterus. Several instruments were modified for this purpose. A tissue punch or foreign body remover with its shaft insulated has proven to be very useful. With sufficient contrast material to outline the filling defect, we are able to secure biopsy specimens from the deeper cervical canal and endometrium. An electrical cutting current separates the specimen from the uterus, which reduces the danger of metastasis that follows the use of a curet. In this manner, very small specimens are obtained without electrical damage to the tissue and the microscopic diagnosis is not obscured. An instrument, designed for this purpose, has been designated a biopsitome.[2]

With a small amount of contrast material in the body of the uterus, other electrosurgical procedures may be conducted. For example, a fallopian tube may be catheterized, the mucosa at the intramural portion of the cornu may be coagulated with the view of closing the oviduct at the intramural portion, thereby creating sterility, etc.

The pathological report from tissue removed from the endometrium with the biopsitome seems more reliable than the report from specimens taken at random from the uterus by surgical curettage. Furthermore, the fact that succeeding specimens may be obtained from a given site in the uterus, that is, a blocked cornu,

Fig. 4.

Fig. 5.

Fig. 4. This uterogram shows the lateral margins which are somewhat irregular in outline but conform generally to the usual triangular shape. The superior margin shows large smooth filling defect which strongly suggests intramural myofibroma.

Fig. 5. Example of early neoplastic change arising from the endometrium. Irregular mucosal pattern on left lateral margin with distinct tumor formation extending into the uterine cavity from the superior margin. Filling defect in cervical canal above the external os, indicating degenerative endocervical changes. Biopsy tissue may be obtained from this endometrial neoplasm with a biopsitome and the fluorescent screen without difficulty.

[2] Orndoff, B. H.: X-rays in the Detection of Pathology of the Cervix Corpus Uteri and Oviducts. Ill. Med. Jour, January, 1936.

a mucosal ruga near the internal os, or a point indicated by a filling defect in the uterogram anywhere, does much to enhance the differentiation of physiological or neoplastic changes in these locations.

The detection of neoplastic tissue arising from the endometrium and the differentiation of its benign or malignant characteristics constitutes one of the most important phases of these investigations. The x-ray findings denote quite clearly the location, and some of the defects take on characteristics which may suggest benignancy or malignancy, but microscopic confirmation is required in all cases. In far advanced cases of malignant neoplasms, biopsitome specimens are usually only confirmatory. In fact, Group IV cases, with extensive invasion, scarcely need a pathological report, and, furthermore, hope for relief by therapy in such cases becomes very low indeed. It is detection early with reliable microscopic differentiation which permits the application of effective therapy.

The effect of treatment studied with x-ray investigations will denote the presence of progression or regression, not possible to obtain by any other method. The irradiation treatment of mucosal hypertrophies, localized hyperplasias of the menopause period, the benign or malignant neoplasms, will show definite changes under x-ray observations, which lead us to decide when adequate or inadequate treatment has been administered earlier than by any other method.

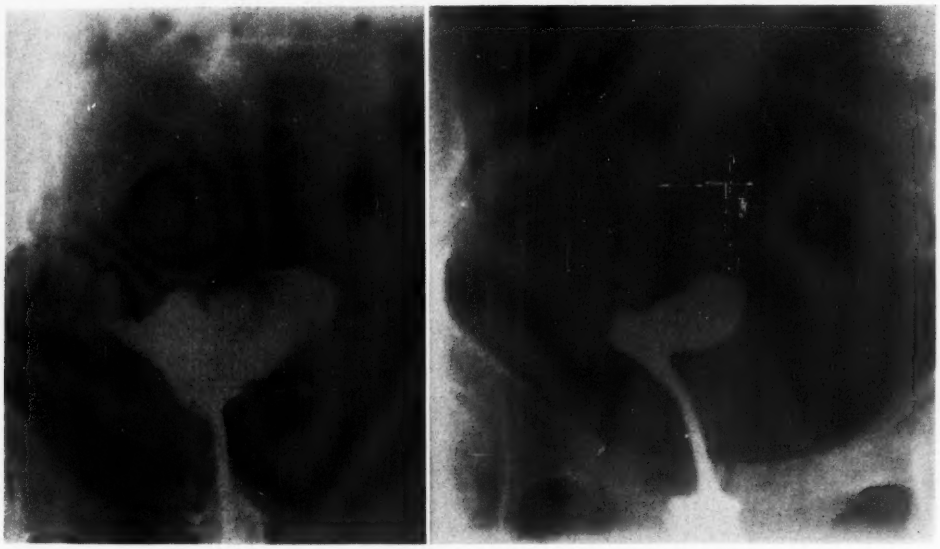


Fig. 6 (*left*). Typical defect of corpus carcinoma before treatment. *Right*. Twelve weeks after treatment. The reduction in size and the disappearing filling defect indicates adequate radiotherapy.

The safety of these diagnostic procedures seems to be established. Our experience over a period of many years and with a series of many hundreds of cases has failed to indicate any clearly defined contraindications. As stated previously, cases are studied carefully before the work is instituted, and it would appear that, with the exercise of carefulness and common sense, undesirable complications are not encountered.

SUMMARY

1. Progress in diagnosis may be the result of perfecting apparatus or improving methods of application.

2. Public education is changing the attitude of the patient, who now demands full information concerning her state of health.

3. The confidence of the patient may be lost unless the physician understands and institutes such special examinations as appear to be required for reliable diagnosis.

4. Uterosalpingography is a safe procedure when ordinary precautions are observed. The technical difficulties of these examinations are not great, and but little special apparatus is required.

5. A filling defect in the uterogram may indicate the site of an early neoplasm and become the guide which leads to its diagnosis and eradication before it has developed sufficiently to cause symptoms or show other physical findings.

6. The study of uterograms, made at selected periods following treatment, will show progression or regression of neoplastic growths not possible to determine otherwise.

7. The uterogram offers very important information in determining when irradiation or any other form of treatment has been adequate or inadequate.

8. The interpretation of filling defects becomes more reliable when studied in conjunction with the pathological report of the tissue composing the defect.

9. The importance of being able to make repeats on the pathological examination of tissue from a definite area within the uterus while it is under therapeutic management can scarcely be over-estimated.

10. In view of the information that may be obtained, x-ray studies of contrast material within the uterus should be instituted as a routine measure before all operations of the uterus; preceding the introduction of radium in cases in which foreign bodies are suspected; to detect the presence of retained products of conception; to find if sterility is due to occluded oviducts; to aid the surgeon in the corrections of sterility when selecting the proper site along the oviduct for creating a new and patulent ostium abdominale; to rule out the corpus uteri where pelvic pathology is uncertain; to denote the presence of infantile and atrophic uteri or subinvolution of the uterus; to disclose the character of the cervical canal after supravaginal uterine amputation; to locate a pelvic abscess which is draining through sinuses into the genital tract. These examinations are indicated in many other conditions.

A DISCUSSION OF GENERALIZED OSTEOSCLEROSIS, WITH A REPORT OF AN UNUSUAL CASE

By PAUL C. SWENSON, M.D., *and* GEORGE G. HOLZMAN, M.D., *New York City*

From the Roentgen-ray Department, Presbyterian Hospital

THE recognition of osteosclerosis *per se* does not present a serious problem roentgenographically Its differential diagnosis from the etiological standpoint, however, is sometimes very difficult and often may be impossible. It has long been realized that the skeleton may exhibit a generalized increase in density as the manifestation of its reaction to various disease processes, such as osteopetrosis (1), aleukemic myeloid leukemia (2, 3, 10), and chemical poisoning such as fluorosis (4). Though far less common, diffuse and widespread osteoblastic carcinomatous metastases may produce similar skeletal changes rather than the usual type of irregular bony condensation. Weber (5, 6) reports an example occurring in a man 45 years of age with a severe anemia and an atypical leukemia, which, on subsequent review of postmortem specimens by Harvey Cushing, was found due to carcinomatous metastases. The case presented "multiple hemangic-endotheliomatous dural lesions" that were shown by him to be carcinomatous metastases to the dura, and the diffuse osteoblastic endosteal reaction was the result of widely disseminated miliary metastases from a carcinomatous prostate gland which had appeared grossly normal at necropsy. Similarly, O'Crowley, Trubek, and Goldstein (7) report a more obvious case in a man 48 years of age, in whom widespread metastases from a moderately enlarged nodular prostate, highly suggestive of carcinoma even during life, brought about the same kind of skeletal response.

The case reported herewith presents a similar appearance.

CASE REPORT

Unit No. 432501, Pathology No. 12262, J. P., a male 36 years of age, an Italian woodworker by occupation, was first admitted to Presbyterian Hospital in October, 1935, complaining of increasing weakness, pain in the back, pallor, and anorexia of about one month's duration. His family history was irrelevant, and his general health until then had been good except for occasional headaches during the previous year attributed to eye strain. For six years he had worked as a wood-carver, and no dangerous chemicals had been used in his work. For two weeks he had drenching night-sweats. Increasing weakness compelled him to stop work. During the week prior to admission his gums bled almost continually. The night before he was admitted, his back pain had become intolerably severe.

Physical examination disclosed nothing important except pallor, sallowness, and bleeding gums. No purpuric spots were present. The liver and spleen were not palpable. Blood pressure 130/70, pulse 90, respiration 21, and temperature 100°.

Blood examination showed the hemoglobin to be 42 per cent; red blood cells, 2,290,000/c.mm.; reticulocytes, 14.6 der cent; nucleated red cells, 5/200; capillary and red blood cell fragility, within normal limits; and polychromatophilia and marked poikilo-aniso-cytosis with both macrocytes and microcytes. White blood cells were 7,300/c.mm., 64 per cent of which were neutrophilic polymorphic leukocytes, eosinophiles 2 per cent, basophiles 2 per cent, lymphocytes 18 per cent, and monocytes 9 per cent. Many young myeloid forms were found. Bleeding and clotting time were each three minutes with normal clot retraction. The erythrocytic sedimentation time was elevated to 50 mm./hr. and the platelets diminished to 68,000/c.mm. Blood Wassermann and blood cultures were negative.

Gastric analysis revealed a total acidity of 12, none of which existed as free acid. Subcutaneous injection of histamine produced no response.

Roentgenographic examination on admission showed the skull and chest to be negative. The cancellous structure of the vertebral column showed a slight decalcification with a peculiar ground-glass appearance, the significance of which was not clear. No evidence of bone destruction was demonstrated. Gastro-intestinal examination was negative.

His condition during his first hospital admission became steadily worse. Bleeding from the gums was almost continuous, back pain became excruciating, retinal hemorrhages occurred, and red cells and hemoglobin progressively decreased to 1,500,000 and 30 per cent, respectively. After blood transfusion he improved considerably. The pain in the back ceased. The red count rose to 3,700,000 and the hemoglobin to 70 per cent. One month after his admission he was discharged with the diagnosis of a secondary anemia and thrombocytopenic purpura, both of undetermined origin.

Fig. 1.

Fig. 2.

Fig. 1. Lateral film of the lower dorsal and lumbar spine shows no evidence of osteosclerosis.

Fig. 2. Lateral film of the lumbar spine showing diffuse osteosclerosis on second admission one year later (*cf.* Fig. 1).

For about ten months he was almost completely asymptomatic. Then he began to experience increasing weakness, dyspnea and palpitation on exertion, dizziness, nausea, painless swelling of the right ankle, and profuse night-sweats. Physical examination on admission one month later, just eleven months following his discharge, revealed an emaciated individual appearing chronically ill and older

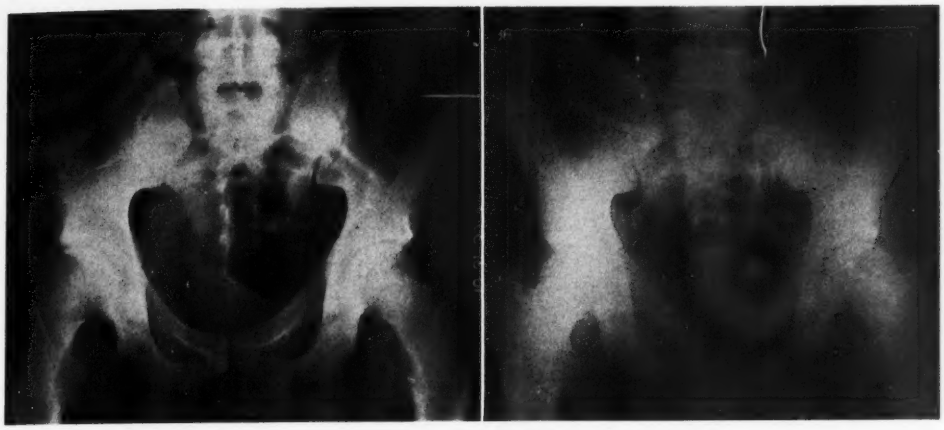


Fig. 3. Fig. 4.

Fig. 3. Anteroposterior film of the pelvis on first admission showing normal appearance.
Fig. 4. Anteroposterior film of pelvis showing diffuse osteosclerosis on second admission one year later (*cf.* Fig. 3).

than the stated age. Skin and mucous membranes were pale. No evidence of purpura was seen. The liver edge was just felt and there was questionable enlargement of the spleen. Some discrete, hard nodules could be felt in the inguinal region.

Blood examination disclosed findings essentially the same as on the first admission. Serum phosphatase and phosphorus were 9.7 units (Bodansky) and 3.7 mg./100 c.c., respectively. Roentgen examination of the chest revealed moderate bilateral accentuation of the bronchovascular markings and a pleural effusion obscuring the right lower lung-field (Fig. 5). The spine showed a diffuse, homogeneous increase in density involving all the segments. Both innominate bones showed the same change (Figs. 2 and 4). The question of fluorine poisoning was raised in spite of absence of ligamentous calcification which is usually associated with the bone condensation, but no history of exposure could be obtained and no dental disturbances that sometimes accompany this disease could be demonstrated.

Following a transfusion his general condition seemed to improve but there was no favorable change in his blood findings. Platelets and reticulocytes dropped sharply, and, after episodes of semi-convulsions, dizziness, and vomiting, he died on the fifth day following admission.

Further roentgen examination postmortem showed the skeleton to be involved diffusely by the osteosclerotic process.

Autopsy showed the ribs, vertebræ, and right femur to be unusually dense. The bodies of the vertebræ had a uniform, pale pink color, and were very hard. Little bone marrow was visible in the ribs and femur. The medullary canal was encroached upon by a wide, ivory-hard cortex, and the canal was filled with heavy trabeculated bone. Only a small amount of bright red marrow could be found. A cross-section of a segment of vertebral body was roentgenographed and showed marked thickening of the trabeculations with no irregularity of their architecture. Microscopic sections (Fig. 7) showed thickening of the bone lamellæ. In some places the bone was almost compact with very small marrow spaces. At these points the lamellæ showed layers as if the thickening had taken place by concentric growth. Only a few osteoblasts and a rare osteoclast were present. The bone cells within the trabeculæ appeared normal in number. The marrow contained fi-

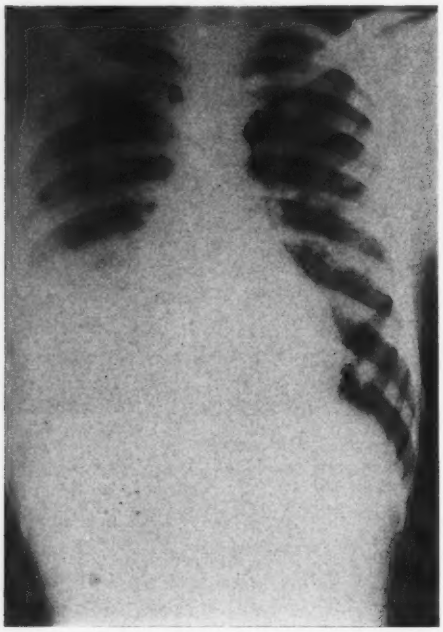


Fig. 5. Film of the chest on second admission showing right pleural effusion and moderately accentuated perivascular and peribronchial lymphatics.

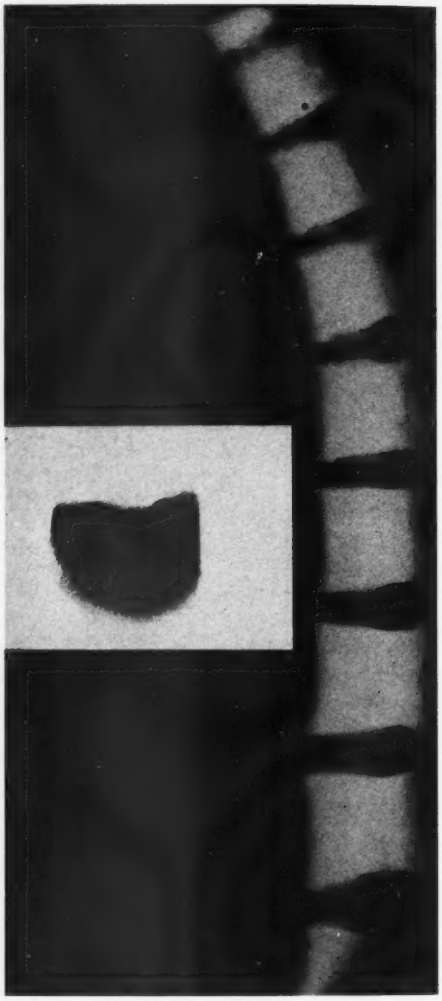


Fig. 6. Postmortem lateral film of a section of the lumbar spine and a film of a cross-section of a vertebra showing diffuse osteosclerosis and thickening of the trabecular structure.

brous tissue for the most part, with very few cells. In a few areas there was slight evidence of hematopoiesis. Comparatively few groups and acini of tumor cells were found. The tumor cell acini contained pale pinkish material. In some places the cells were arranged in groups; cells were epithelial in type, mainly cylindrical or cuboidal. The nuclei were dark blue staining with a surrounding pinkish cytoplasm. Some of the cells showed a distinct cuticular border. Mitotic figures were rarely seen. Chemical determinations for lead were within normal values, namely, 2 mg./100 grams of bone; no arsenic, strontium, or fluorides were present. The calcium content by chemical analysis was found to be much higher than in normal bone, but the Ca:P ratio was normal. Physical examination of the bones revealed marked hardness and resistance to fracture. Microscopic section of the usual type of osteoblastic metastases (Fig. 8) and one of the osteolytic type (Fig. 9) are shown for comparison.

The lungs showed a complete collapse of the lower lobe on the right, produced by a pleural effusion. The left lung, on section, showed patchy areas of reddish, finely granular parenchyma. All the microscopic sections of the lungs showed the lymphatics to be invaded by epithelial cells. The muci-carmine stain showed some of the cells to be mucin-producing.

The lymph glands throughout the body were invaded by the same sort of tumor tissue. The gross and microscopic examination of the stomach failed to show any evidence of a primary neoplasm even on serial histologic section of the entire organ. Areas of extra-medullary hematopoiesis were observed in the liver and spleen. All the other organs were essentially normal, including slightly more than half of the prostate for the remainder of the organ had been left behind in the body without microscopic examination.

The diagnosis was that of an adenocarcinoma metastasizing widely through the lymphatics of the lungs, the thoracic and abdominal lymph nodes, and the marrow of the affected bones. In spite of careful search the primary site of the growth remained undiscovered. A hint as to the possible origin from the alimentary epithelium was given by the production of mucin and a cuticular border. However, the prostate cannot be definitely excluded as a possible source since a portion of the gland was unfortunately left in the body.

DISCUSSION

In spite of the fact that the site of the primary tumor could not be determined at necropsy, this case most probably belongs to the group of carcinomas recently described by Jarcho (8) as occurring in young adults and characterized pathologically by (1) a primary lesion usually in the stomach, most often of the scirrhous type; (2) diffuse lymphatic type of pulmonary metastatic involvement, and (3) skeletal metastases with thrombocytopenic purpura and anemia. Symptoms and signs are referable predominately to the latter two groups of lesions, with rapidly increasing dyspnea, cyanosis, unproductive cough without hemoptysis or distinctive physical signs, and accompanied by purpuric hemorrhages and anemia with evidence of extra-medullary hematopoiesis. The gastric lesion which Jarcho described may cause no symptoms directly referable

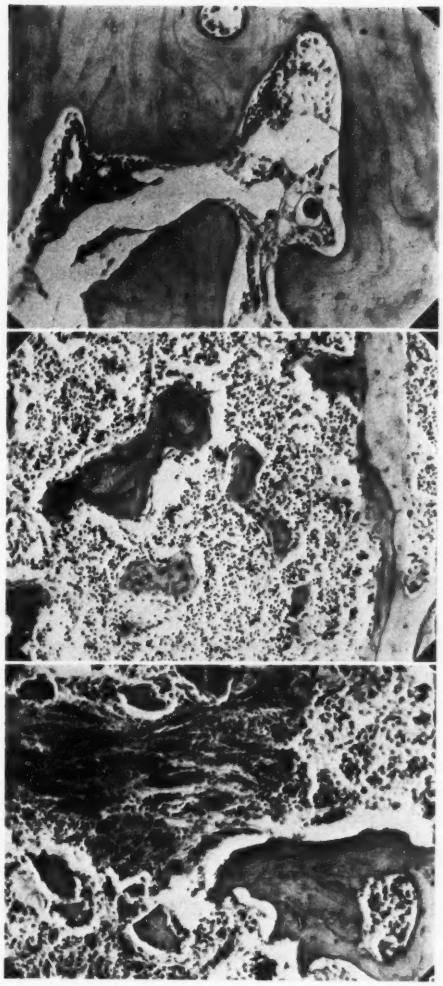


Fig. 7 (*top*). (Path. No. 12262.) Histological section through body of one of osteosclerotic vertebræ in the case reported above showing bone composed of closely arranged, dense, wide trabeculæ enclosing narrow marrow spaces. A single small acinus of tumor cells is present in the field. Osteoblasts are inconspicuous. ×-110 (*cf.* Figs. 8, 9).

Fig. 8 (*center*). (Path. No. 12148.) Section through a lumbar vertebra in a case of osteoblastic metastases from carcinoma of the prostate with less bone production than in preceding figure. There is a diffuse infiltration of small tumor cells between partially calcified new trabeculæ. Also deposition of new bone along old trabeculæ. Numerous osteoblasts. ×-110 (*cf.* Figs. 7, 9).

Fig. 9 (*below*). (Path. No. 12172.) Section through lumbar vertebræ in a case of osteolytic metastases from carcinoma of the female breast showing no reactive bone proliferation. Extensive necrosis and destruction of bone trabeculæ. ×-110 (*cf.* Figs. 7, 8).

to itself. It may not be detected in gastrointestinal examination because it may be very small and because it is usually of the flat, diffusely infiltrating type. It may, therefore, be discovered only on careful postmortem examination, if at all.

The diffuse spread of anaplastic tumor cells through the lymphatics is believed to account for the lesions and accompanying symptoms and signs. The pulmonary lymphatics are filled with these tumor cells, which in the gross specimen may appear as minute granules and finely radiating lines, though sometimes no gross changes are visible. Roentgenographic visualization depends on the degree of fibrosis excited. As in the case herewith reported, the lymph nodes throughout the body may show evidence of tumor cells. It is believed that the cells, especially when unrestricted by much stroma, find their way through the thoracic duct into the blood stream and thence to the bone marrow, replacing the latter to a great extent and thereby probably accounting for the anemia and thrombocytopenic purpura.

From the roentgenologic standpoint it is of unusual interest to consider the remarkable response of the skeleton to invasion by the tumor cells. When osteoblastic skeletal metastases occur, they usually produce areas of irregularly and unequally increased density within one or more bones. In our case the skeleton presented a diffuse, homogeneous increase in density throughout. All the bone trabeculæ are increased to almost twice their normal thickness, but retain their normal arrangement, thus producing the apparent ivory-like density of the bones observed on films and at necropsy. This is especially well shown in the roentgenogram of the cross-section of a single vertebra (Fig. 6). No explanation for this peculiar reaction is available. It has recently been shown (11) that the phosphatase activity of bone in the region of osteoblastic metastases may be increased considerably, and the serum phosphatase, in consequence, may be higher than normal. In our case the serum phosphatase value was 9.7 units (Bodansky), which exceeds the normal limits of 1.0–4.0 units (Bodansky), but it is not as high as often occurs with fairly widespread osteoblastic changes. This and the relatively few osteoblasts suggest that bone production was not very active during the terminal stages of the disease.

Any one of several diseases may produce a roentgenologic picture in the adult simulating that described above. Osteopetrosis or "marble-bone" disease of Albers-Schönberg (1) is recognized by bony condensation throughout the skeleton. Though frequently discovered in adult life, it is a disorder which has its inception in pre-adult years during the period of active growth and differentiation of the skeleton, and hence all the basic pathologic changes are completed before adult life is attained. It is significant that in osteopetrosis a history may be elicited of repeated fractures due to slight or even no trauma. Roentgenograms may reveal widening of the extremities of the long bones with alternating transverse bands of contrasting density, and thickening of the posterior clinoid processes of the skull. These are considered as characteristic findings along with the generalized diffusely homogeneous osteosclerosis. Anemia is a constant accompaniment of the observable x-ray changes, and extra-medullary hematopoiesis may be in evidence as shown by the hepatosplenomegaly.

The question arises as to the validity of any diagnosis of "marble-bone disease" in the adult by roentgenographic and clinical examination without autopsy for final verification, such as in the case reported by Stenström (9) in a man 58 years of age on whom no necropsy was performed. We have seen how Weber's case, after reconsideration of the autopsy findings, turned out to be one of metastatic carcinoma. It is quite likely that if our case had not come under observation so early in its course, it might have been erroneously classified under osteopetrosis.

Chemical poisons like fluorine may produce a widespread diffuse osteosclerosis. A history of long continued exposure is

most important in the diagnosis. Mottled enamel and disordered growth, form, and size of the teeth are characteristic in those exposed to fluorine since childhood. Bone production is both periosteal and endosteal, and is accompanied by ligamentous calcification. The general condition of the patient is unusually good. The serum phosphatase is usually not elevated in chronic fluorosis (12).

Anemias, leukemias, and atypical blood dyscrasias have been shown to produce similar skeletal reactions (10). Jores (2) and Reiche (3), reporting the same case, show that in the terminal phases of aleukemic myeloid leukemia a homogeneous, diffuse osteosclerosis may occur, identical with that encountered in our patient. Their patient responded to roentgen irradiation for 12 years before exodus.

SUMMARY

A case of generalized osteosclerosis in an adult is reported with roentgenographic evidence of its development almost from its inception to its termination over a period of about twelve months. The patient complained of weakness, anorexia, pallor, night-sweats, and back pain. He presented evidence of anemia and thrombocytopenic purpura. Postmortem examination revealed the condition to be the result of an unusual osteoblastic skeletal reaction to widespread carcinomatous metastases from an undetermined primary site. It seems possible that this case belongs to the group recently described by Jarcho in which carcinomatous metastases spreading *via* the lymphatics were associated with thrombocytopenic purpura and anemia.

The usual roentgenographic manifestations of disseminated osteoblastic metastases are not difficult to recognize. Generalized osteosclerosis, on the other hand, is difficult to classify from the etiologic standpoint, as several causes for this condition have been demonstrated. The etiology, as in the case reported herewith, may be revealed only after careful study of necropsy material.

We are indebted to the Department of Pathology, College of Physicians and Surgeons, Columbia University, for the pathologic sections reproduced (Figs. 7, 8, and 9).

REFERENCES

(1) McCune, D. J., and Bradley, C.: Osteopetrosis (Marble Bones) in an Infant. Am. Jour. Dis. Child., **48,** 949–1000, 1924.

(2) Jores, A.: Ein Fall von Aleukämischer Myelose mit Osteosklerose des Gesamten Skelettssystems. Virchow's Arch. f. Path. Anat., **265,** 845–851, 1927.

(3) Reiche, F.: Aleukämische Myelose und Osteosklerose. Med. Klin., **23,** 981–983, 1927.

(4) Roholm, K.: Fluorvergiftung, eine "neue" Krankheit. Klin. Wchnschr., **15,** 1425–1431, Oct. 3, 1936.

(5) Weber, F. P.: Specimens from a Case of Osteosclerotic Anemia or Leukemia. Tr. Med. Soc. London, **52,** 99–103, 1928–1929.

(6) Idem: "Secondary Marble Bone Disease," Lancet, **1,** 377, 378, Feb. 16, 1935.

(7) O'Crowley, C. R., Trubek, M., and Goldstein, H. H.: Osseous Metastasis in Carcinoma of the Prostate. Jour. Urol., **26,** 672–699, November, 1931.

(8) Jarcho, S.: Diffusely Infiltrative Carcinoma; Hitherto Undescribed Correlation of Several Varieties of Tumor Metastasis. Arch. Path., **22,** 674–696, November, 1936.

(9) Stenström, B.: Über Marmorskelette. Acta radiol., **17,** 191, 1936.

(10) Overgaard, K.: Ein Fall von osteosklerotischer Anämie. Acta radiol., **17,** 51–67, 1936.

(11) Gutman, E. B., Sproul, E. E., and Gutman, A. B. Significance of Increased Phosphatase Activity of Bone at the Site of Osteoplastic Metastases Secondary to Carcinoma of the Prostate Gland. Am. Jour. Cancer, **28,** 485–495, November, 1936.

(12) Roholm, K., Gutman, A. B., and Gutman, E. B.: Serum Phosphatase Activity in Generalized Osteosclerosis Due to Chronic Fluorine Intoxication in Man. Proc. Soc. Exper. Biol. and Med., **37,** 376–379, November, 1937.

FURTHER OBSERVATIONS CONCERNING THE RECOVERY OF LOST RADIUM[1]

By ROBERT B. TAFT, M.D., B.S., M.A., F.A.C.R., *Charleston, South Carolina*

DESPITE all care in the handling of radium, losses continue to occur with surprising frequency, probably the greatest contributing factor being that radium is almost invariably associated with contaminated dressings which the average hospital attendant wishes to remove as rapidly as possible.

Some time ago, I presented a paper on the recovery of lost radium (1), up to which time the work had been done with the electroscope, but in the discussion of the paper Weatherwax and Glasser, independently, called attention to the great value of the Geiger-Müller Counter. On seeing the instruments of these two physicists, I realized that the electroscope was practically obsolete, and undertook certain experimental work in simplifying these counters. Following the publication of two papers (2 and 3), and several exhibits in which these instruments figured, I have received many inquiries as to the conditions under which these instruments may be successfully used.

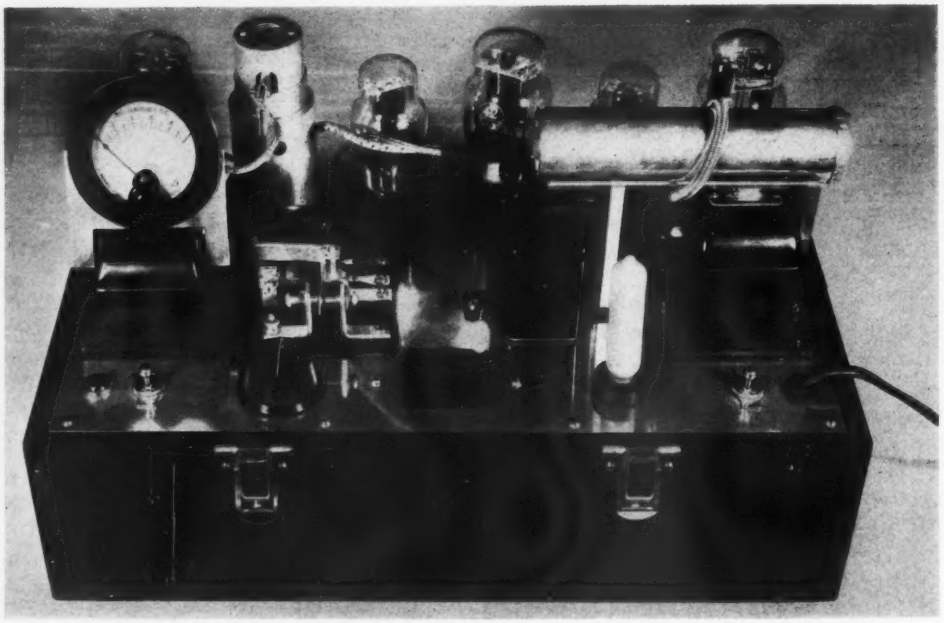


Fig. 1. The author's A.C. operated Geiger-Müller Counter, cover removed. The Locher tube is in the metal shield can on the upper right attached by 6-foot cable. The meter at the upper left shows the voltage applied to the cathode of the Locher tube. The register, in the front center, records the number of impulses.

Briefly, the Geiger-Müller Counter may be described as an instrument for detecting and/or measuring extremely small amounts of gamma and certain other rays. It consists of a sealed tube containing a gas at sub-atmospheric pressure. On the cathode of this tube is placed a relatively high voltage which is almost sufficient to break down the low pressure. The anode is connected

[1] Read before the Fifth International Congress of Radiology, Chicago, Sept. 13–17, 1937.

to a system of vacuum tube amplifiers. The entrance of any radiation into the tube momentarily breaks down the space between the electrodes causing an impulse which may be magnified to operate a loud speaker or some type of recording apparatus.

Fig. 2. The author's battery set: apparatus lifted out of the case. Batteries are concealed in bottom. The shield box contains the vibrator, condenser, and rectifier tube. The small speaker on the right signals the impulses which the operator may record on the "tally counter."

I have developed two counters which have given excellent service for this work. The A.C. (Fig. 1) set is essentially the same as has been described (2) except that it was found that different line voltages caused some difference in the number of impulses. This was later eliminated by a voltage regulating system and meter. This is nothing more than a 200-ohm rheostat in the primary of the transformer that supplies the high voltage to the tube. The meter is a 0 to 1 milliampere meter, with a resistor of about 5 megohms in series, giving an arbitrary but constant reading which enables the operator always to use the same voltage on the cathode of the Locher tube.

The battery (Fig. 2) has also been equipped with the meter as described

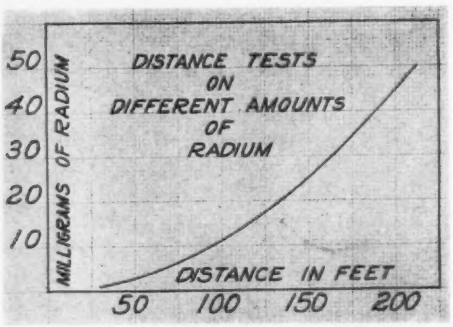


Fig. 3. This curve enables one to determine the maximum distances at which radium may be detected. The term, "detection," as used here, means sufficient radiation to double the base count of the machine. By taking long counts, a careful operator can record these amounts of radium at considerably longer distances than shown here.

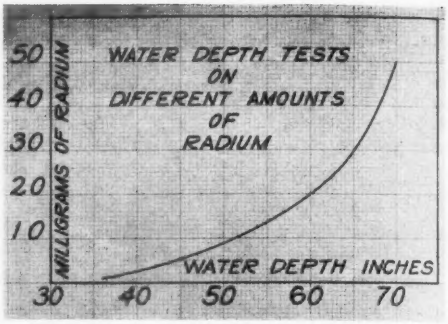


Fig. 5. This curve enables one to determine at what depth a given quantity of radium may be detected ("detected," as defined for Figure 3).

above, the vibrator of the coil being adjusted to give the proper voltage. The Type 30 radio tube which was used as a rectifier for the high voltage has been replaced by a Ratheon "BR" cold cathode tube which is just as satisfactory and simplifies the wiring. A hand-operated "tally register"[2] adds greatly to the convenience of counting the impulses as they come through the loud speaker. The battery set gives complete freedom from the need of line connections but, of course, must be supplied with fresh cells periodically. Other small improvements have been made in the circuit and subsequently described (4).

These instruments are sensitive enough to record cosmic rays, so they constantly operate even though no other radiation may be entering. Generally eight to ten impulses are recorded from cosmic rays and a greater number indicates the presence of some other radiation.

In the search for lost radium, there are two methods of using these instruments: The first method is simply to carry the machine around from one suspected location to another until a difference in the

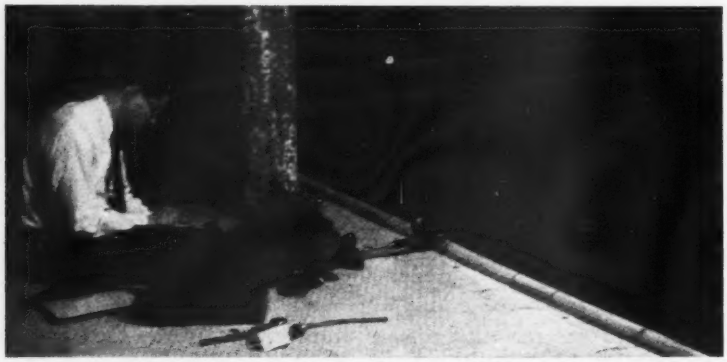


Fig. 4. Method of determining water penetration: Locher tube suspended over water; radium lowered to different depths by fishing reel.

[2] Keuffel and Esser, No. 1748.

number of impulses is noticed, the second method being to make a count of the impulses for a period of several minutes in each location. The second method must be followed when the amount of radium is very small or when it could be buried, submerged, or behind brick walls.

Lost radium seems to be able to get itself into strange places, as, for example, in a sewer creek where a short time ago a well known radiologist was cruising around in a row boat hoping to locate it. Some of the questions asked me are: "How far away may radium be detected?" "In what depth of water?" "If it is under the ground in a sewer pipe, how much dirt could it penetrate?" The better to answer these questions, I have undertaken certain experiments to determine the distance at which a given quantity of radium may be detected and with different intervening materials acting as filters.

It seemed that the first experiment would be to determine the maximum distances at which any given quantity could be detected. The term "detection" is necessarily a questionable one, but in all these tests the critical point was chosen in which the number of impulses which the machine normally received from cosmic radiation and accidental radio-activity would be doubled. In the hands of a careful operator, a smaller number of impulses would be easily recognized but an effort is made to use extreme conservatism in all the tests. Different samples of radium in a heavy brass capsule were carried to a large vacant lot and the counter set up on the edge, counts being made at different distances. With the 50 mg., the end point was about 212 feet; with the 25 mg., 150 feet; with the 12.5 mg., about 106 feet, and with 1 mg., about 30 feet. This, it will be noted, obeys the simple law of inverse squares. The graph (Fig. 3) would enable one to determine the end point for other amounts of radium.

Tests in water followed this. An indoor swimming pool of fresh water was chosen, as it seemed a bit risky to submerge radium in the Atlantic Ocean. The Locher tube was suspended a few inches above the surface of the water and the radium lowered to different depths by a reel (Fig. 4). The end points were found approximately as follows: 1 mg., 36 inches; 12.5 mg., 54

Fig. 6. A typical house that may be searched for any reasonable amount of radium by the battery-operated counter in the parked automobile. In this case, 25 mg. could be detected when located in that part of the house farthest from the automobile.

inches; 25 mg., 63 inches; 50 mg., 70 inches. Other amounts of radium may be estimated by reference to the curve (Fig. 5), which is, of course, the combination of inverse squares and densities.

Neither the air distances nor the water depths are to be taken as precision figures but will serve well as a guide. They at least show the futility of making surface tests over deep water, and show the necessity of placing the Locher tube in a sealed rubber tube which may be lowered to the bottom.

Brick and dirt are substances which often figure in actual searches for lost radium, so some effort was made to test their densities. One milligram was tested through a 17-inch brick wall (density about 120 pounds per square foot); by being buried in dirt 17 inches below surface (density about 100 pounds per square foot); also same amount submerged in 17 inches fresh water (density about 82 pounds per square foot). It was found that the number of impulses recorded in each case was reasonably close to the theoretical number expected on the basis of density. The expense involved in making more elaborate tests in different thicknesses of dirt and brick seemed scarcely warranted, but the above figures will allow a rough analysis to be made of any actual problem, as brick or dirt will have something like twice the absorptive property of water.

In practically every radium loss, there is some question as to the possibility of theft. The suspicions are always so vague that no accusations can be made without incurring enmity if not actual liability. With one of these instruments, preferably a battery set, a search can be made of the living quarters of all of the suspects without their knowledge, and, even if it were found out, no liability could be incurred, as the searcher does not have to enter the suspect's property. As shown in Figure 6, the counter in the parked automobile can search the average small house for any reasonable amount of radium. To satisfy the curiosity of anyone who may happen along, the explanation can be given that tests are being made for radio interference from power lines. Having made a large number of experiments on different houses, I suggest that this method be used with caution on a large house or a house constructed of brick or stone. It is well to assume that the radium must not be farther than one-fourth of the detectable air distance. It has further been suggested that anyone who is sufficiently familiar with radium to steal it, may know enough to enclose it in sufficient protection to screen it.

In conclusion, the idea of an instrument that can detect radium at long distances and through heavy walls is rather incredible to most persons, including many radiologists. For that reason, one who attempts to find lost radium may be the victim of many "wise cracks," and much concealed laughter. I find that the searcher will be much more respected if he will carry out this simple procedure: on entering the office of the one who has sustained the loss, the searcher should say, "Do not tell me whether or not you have any radium in your safe, or elsewhere in this office, because in two minutes I will find any that you may have." This procedure is so spectacular that it will gain much respect for the searcher and assure him the kind of cooperation necessary for success.

Indebtedness is expressed to Mr. King Couper, B.S., for his assistance in making these tests.

105 Rutledge Avenue

REFERENCES

(1) TAFT, ROBERT B.: Lost and Found Radium. Am. Jour. Roentgenol. and Rad. Ther., **37,** 87–92, January, 1937.

(2) Idem: Technical Data Concerning the Geiger Counter. RADIOLOGY, **26,** 756, 757, June, 1936.

(3) Idem: Battery-operated Geiger-Müller Counter with New Type of Voltage Supply. RADIOLOGY, **27,** 616, 617, November, 1936.

(4) Idem: Battery-operated Geiger-Müller Counter for the Location of Lost Radium. Rev. Scientific Instruments, **8,** December, 1937.

This material, along with the most interesting radium searches, and conclusions based on 107 radium losses, has been published in book form—"Radium, Lost and Found," J. J. Furlong & Son, Charleston, S. C., 1938.

ANOMALIES OF THE CLAVICLE, WITH A PREVIOUSLY UNREPORTED VARIATION

By CHARLES LIEBMAN, PH.B., M.D., *and* NEWMAN B. FREEDMAN, M.D., Jewish General Hospital, *Montreal, Canada*

CLAVICULAR dysostoses have been recognized for a long time. Morand (1) reported the first case in 1776, Barlow (2) the second group of cases in 1883, and in 1889 Hamilton (3) added his case to the literature, to make a total of 21. Since that time, a large number of cases have been recognized and reported.

Familial incidence is common. McCurdy and Baer (4) reported an incidence of nine cases out of 13 individuals examined in three generations of one family. Villaret and Francoz (5) reported a woman and her three children, all of whom had clavicular anomalies. Langsmead (6) found 18 cases in four generations of one family. Stern (7) reported absence of clavicles in seven males of the same family whose four female members had normal clavicular development.

Several theories have been expressed as to the probable etiology of some of these malformations. The most tenable one seems to be that of Kelley (8), who states that cranio-cleido-dysostosis is a congenital abnormality inherited as a dominant Mendelian factor affecting bones which are laid down originally in membrane. Interference with, or arrest of, development of bone from membrane is assumed to produce these abnormalities.

Piersol (9) states that the ossification center of the clavicles is the earliest bony center laid down in the body and can be found during the sixth week of intra-uterine life. Cartilaginous outline appears rapidly, and by the sixteenth week the clavicle is ossified and well developed (10). The center of the shaft ossifies first, so that in order to explain malformations it must be assumed that some irregularity in development has occurred within the first two months of intra-uterine life. Spriggs (11) states that although this ossification starts usually from a single centrally placed center, it is possible that ossification may occur also from other centers in the two ends of the clavicles. Thus, in cases in which arrested or absent center ossification occurs, bony growth is dependent upon that which takes place from the ends inward toward the middle.

Defective clavicles are found to be associated usually with congenital anomalies elsewhere in the body. Fitz-Williams (12) found anomalies of the face or of the skull in 40 out of 60 cases reported in the literature. Deformities of ribs, scapula, pelvis, spine, and fingers are frequently reported (13) in conjunction with these clavicular defects. McCurdy and Baer (4), Stewart (14), Marie and Sainton (15), Léri and Trétiakoff (16), Stocks (17), Fitchet (18), and others (19 and 20) have reported malformations in the brain and central nervous system.

In cases in which there has been interference with, or absence of, the normal ossification center, variations from a false joint to complete absence of clavicles may occur. These anomalies are dependent upon the amount of growth which takes place from the other centers of ossification in the lateral portions of the bone. One may find cases of total absence of clavicles; partial or half developed clavicles, and cases having clavicles divided into two parts approximately at the center with a false articulation at the point of division.

True complete absence of the clavicles apparently has not been reported in the literature, although in some cases roentgenographic evidence of any bony structure is difficult to visualize. In these cases, the bony clavicle is replaced essentially by membrane and from the outer ends there is an ingrowth of bone in two segments. If this growth is minimal, all that can be found are tiny bony fragments. If the bony growth is an inch or more in length,

these fragments may be palpated and moved rather freely. If this growth is fairly mature in its extent, there is a complete clavicle, save that it has the central false articulation as noted previously. Walsham, Grass, and others (21) have reported cases in which only one-half of the clavicle has developed; this half clavicle may be fairly mature and the other half only partially developed, or absent.

Several other anomalies have been described. One of these is the presence of a foramen almost in the center of the clavicle through which passes the supraclavicular nerve or one of its branches. In a specimen of this anomaly in the McGill University Pathological Museum, and also in a case reported by Skarby (22), this foramen is a definite canal. Skarby was able to demonstrate roentgenologically 15 cases having such a canal unilaterally in 1,000 selected patients examined. Cruveilhier (23) found a case wherein this canal was replaced by a groove on the outer border of the clavicle. This groove was bridged over by a ligament to complete the canal.

Another anomaly described by Cyriax (24) had a floating inner end of the clavicle. Instead of fitting into the articulation with the manubrium and being closely attached to it, it lay free with a considerable range of movement, restrained only by a loose joint capsule which attached it to the sternum. Cyriax has reported 12 cases of this "floating clavicle," 11 of which had this anomaly unilaterally; in only one did it appear bilaterally. This abnormality did not cause any inconvenience to the individuals.

Pendergrass and Hodes (25) described the occurrence of a rather large, irregular hollow on the antero-lateral surface of the clavicle. This hollow area may vary considerably in size and is called the rhomboid fossa. It is to be distinguished from a pathologic erosion of the bone.

An additional anomaly described here occurred in a male of 15 years who came to the Surgical Clinic of the Jewish General Hospital of Montreal complaining of pain of several months' duration, in the region of the left clavicle. This pain was dull in character, worse at night, and affected by weather changes; it was referred upward to the side of the neck. Movements of the shoulder were unrestricted and did not cause any exaggeration of the pain. No points of tenderness could be elicited and no abnormalities in the shape of the clavicle could be palpated. There was slight elevation of the scapula on the same side. Roentgenographic examination showed (Fig. 1) a lack of development of the lateral ends of both clavicles. There were also bony projections downward from the inferior margins of both clavicles toward the coracoid processes. An ossification center was noted in each coracoid process at a point opposite the bony protuberances extending down from the clavicles, suggesting attempted formation of articulations at these points. No other abnormalities of

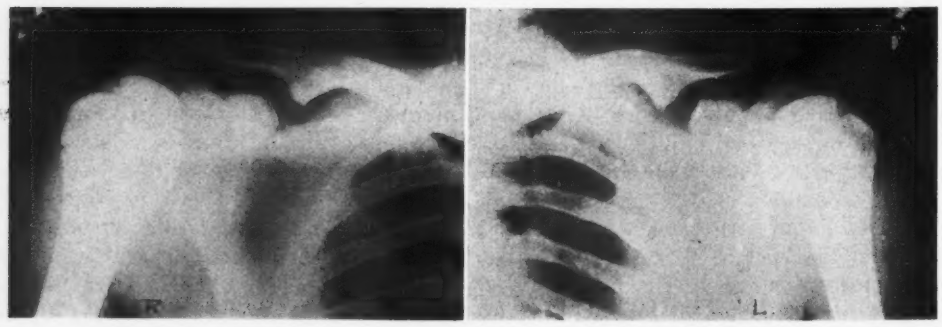


Fig. 1.

bony development were present in this patient. Examination of other members of his family failed to reveal any abnormal developmental changes. Apparently these unusual anomalies occurring in this patient are the result of some derangement of development or disturbance of the ossification centers, as in the other anomalies mentioned previously.

A case reported in 1936, by Seshachalam (26), has some features comparable with this case. His patient had bilateral bony processes similar to the anomaly reported here, but with normal development of the acromial ends of both clavicles. The main feature of Seshachalam's report was to demonstrate a case having one clavicle consisting of two portions joined together by a typical diarthrodial joint. However, his illustrations showed an additional abnormality in that the medial half of the divided clavicle showed definite broadening in the vertical plane.

SUMMARY

Various previously reported anomalies of the clavicles and their probable causes are reviewed. An additional anomaly is presented in which the congenital deformity is a bilateral bony projection from the inner aspect of the outer third of the clavicles somewhat medial to the position of the conoid tubercles, and also bilateral incomplete development of the acromial ends of both clavicles. This anomaly is recognized readily as a developmental change and offers no difficulty in distinguishing it from any pathologic process.

BIBLIOGRAPHY

(1) MORAND: Reported by McCurdy and Baer.

(2) BARLOW, T.: British Med. Jour., **1,** 909, 1883.

(3) HAMILTON, W. F.: A Case of Congenital Deficiency of Both Clavicles. Philadelphia Med. Jour., **4,** 720, 721, 1899.

(4) MCCURDY, I. J., and BAER, R. W.: Hereditary Cleidocranial Dysostosis. Jour. Am. Med. Assn., **81,** 9–11, July 7, 1923.

(5) VILLARET and FRANCOZ: Reported by McCurdy and Baer.

(6) LANGSMEAD, W.: Proc. Roy. Soc. of Med. Dis. of Children, **1,** 1916.

(7) STERN, WALTER G.: Report of Case of Congenital Absence of Both Clavicles. Jour. Am. Med. Assn., **73,** 1526.

(8) KELLEY, ARTHUR: Hereditary Absence of Clavicles. Jour. Hereditary, **20,** 353–355, August, 1929.

(9) PIERSOL, GEORGE: Human Anatomy. J. B. Lippincott, Philadelphia, p. 258, 1907.

(10) KLEMMER, R. N., SNOKE, PAUL O., and COOPER, H. K.: Cleidocranial Dysostosis. Am. Jour. Roentgenol. and Rad. Ther., **26,** 710–715, November, 1931.

(11) SPRIGGS, E. I.: A Case Showing Division of the Clavicles into Two Halves, Having Other Bony Deformities: Cleidocranial Dysostosis. Lancet, **2,** 1599, 1600, 1907.

(12) FITZ-WILLIAMS, D. C. L.: Hereditary Cranio-cleido-dysostosis. Lancet, **2,** 1466, 1910.

(13) TERRY, R. J.: Rudimentary Clavicles and Other Abnormalities of the Skeleton of a White Woman. Jour. Anat. and Physiol., **33,** 413, 1899.

Idem: A Skeleton with Rudimentary Clavicles, Divided Parietal Bones, and Other Anomalous Conditions. Am. Jour. Anat., **1,** 509, 1901.

(14) STEWART, R. M.: Nervous System in Cleidocranial Dysostosis: Report of Case. Jour. Neurol. and Psychopath., **9,** 217–221, January, 1929.

(15) MARIE, PIERRE, and SAINTON, PAUL: Observation d'Hydrocephalie (père et fils) par vice de Development du Crane et du Cerveau. Bull. et. mem. Soc. Med. d'Hôp. de Paris, **14,** 706 ,1897.

(16) LÉRI, A., and TRÉTIAKOFF: Autopsie d'une Dysostose Celido-cranienne, grosse Lesions inflammatoires et hemorrhagiques Meningo-encephaliques. Bull. et mem. Soc. Med. d'Hôp. de Paris, **47,** 1091–1098, July, 1923.

(17) STOCKS, PERCY: Hereditary Disorders of Bone Development. (The Treasury of Human Inheritance. Edit. Karl Pearson. Eugenics Lab. Mem., 22.) Camb. Univ. Press, London, 1925.

(18) FITCHET, S. M.: Cleidocranial Dysostosis: Hereditary and Familial. Jour. Bone and Joint Surg., **11,** 838–866, October, 1929.

(19) BISDOM, C. W., and MULDER, D.: Cleidocranial Dysostosis: Cases. Nederl. Maandschr. v. Geneesk., **15,** 195–206, 1928.

(20) DAVIS, WOLFE, and FLECKER, H.: Congenital Absence of Clavicles. (Hereditary Cleidocranial Dysostosis). Med. Jour. Austral., **2,** 533, October, 1928.

(21) WALSHAM, GRASS, and others: Reported by Spriggs.

(22) SKARBY, H. G.: The Foramen of the Clavicular Nerve in Roentgenograms. Acta Radiol., **17,** 397–402, 1936.

(23) CRUVEILHIER: Reported by Skarby.

(24) CYRIAX, EDGAR F.: A Brief Note on "Floating Clavicle." Anat. Rec., **52,** 97, Feb. 25, 1932.

(25) PENDERGRASS, E. P., and HODES, P. J.: Am. Jour. Roentgenol. and Rad. Ther., **38,** 152–155, July, 1937.

(26) SESHACHALAM, T.: Clavicle in Two Parts. Ind. Med. Gaz., **71,** 593, October, 1936.

X-RAY STUDIES ON THE EFFECT OF OPIUM ON THE GASTRO-INTESTINAL TRACT IN MAN

By EGBERT H. FELL, M.D., *Chicago*

From the Division of Roentgenology, University of Chicago

INTRODUCTION

IN spite of the fact that opium is an ancient drug and one much used in treating certain bowel conditions, there is little exact knowledge as to the nature of its action on the gastro-intestinal tract, particularly in man.

This report contains the results in the study of three normal subjects on whom repeated gastro-intestinal x-ray examinations were conducted during protracted administration of opium. There is also presented a series of control observations on the same subjects at times when they did not receive the drug.

The Technic of the Examination.—A drink was made up as follows:

dry malted milk	10 grams
barium sulphate	300 grams
sweetened chocolate syrup	15 grams
water to make a total content of	500 c.c.

This was placed in pint milk bottles and kept in the refrigerator. At mealtime each subject took a bottle of the mixture to the cafeteria and used it as a beverage while eating an ordinary lunch.

The night preceding the taking of barium each subject received a dozen or more small pills, tablets, or capsules, the content of which was unknown to him. One of these was taken at bedtime, the second before breakfast, and a third just before the lunch containing the barium. One hour after this lunch the subject presented himself in the x-ray room, where a fluoroscopic examination was done and a roentgenogram made with the subject lying on his face on the Potter grid. Following this, the subject was urged to resume his ordinary activities and allowed to take food and water as he chose.

Four hours after barium, another examination was conducted and another roentgenogram made with the subject prone if barium was still in the stomach, or supine if the stomach was empty. A pill was taken before the evening meal and examination was repeated eight hours after the taking of barium. At bedtime another pill was taken, and this was repeated before each meal and at bedtime until the bowel was completely empty of barium. As far as possible, the meals were patterned after those of the first day. A fluoroscopic examination was conducted and a roentgenogram made at 24 hours, at 48 hours after the barium and, if need be, at 72 and again at 96 hours. As soon as the bowel was found to be free of barium (this ranged from less than 48 to not more than 96 hours), the experiment was discontinued and the subject was allowed to rest one or more weeks before being seen again.

Methods of Observation.—When a series was complete the roentgenograms were studied along with detailed notes made at the time of the fluoroscopic examinations. Film tracings were then made, the spine, pelvis, and ribs being outlined in black, the stomach cross-hatched, and the bowel pencil-shaded to indicate the density of the barium shadow. These tracings were photographically reduced to about one-thirteenth full size.

Control Observations.—Student No. 1 submitted to four control series; students Nos. 2 and 3, to three. Small placebo pills were given as described in previous paragraphs.

Observations during the Administration of Opium.—Approximately two months later, during which time control figures were being obtained, the opium studies were begun. Every effort was made to repeat exact conditions, except that sugar pills

were replaced by one-half grain doses of opium given as pills, tablets, or capsules.

Student No. 1 submitted to three opium series, students Nos. 2 and 3 submitted to four. The roentgenograms of all the series were sketched and are reproduced here, together with the sketch of the control series for comparison.

The stools two days prior to each opium series were in all cases normal, well formed, easily expelled, and of normal consistency. After taking opium there was constipation, except during Series No. 4, when students Nos. 1 and 2 were not constipated although the same drug was used as in Series No. 3. The stools were small, hard, and dry. Marked difficulty was experienced in passing them and at times defecation was impossible. In spite of this the desire to go to stool was increased. The urge came as often as three or four times a day, normally once or twice.

Barium Enema Observations.—Four barium enemas were administered to each subject, two following the taking of placebo pills, as controls, and two following opium.

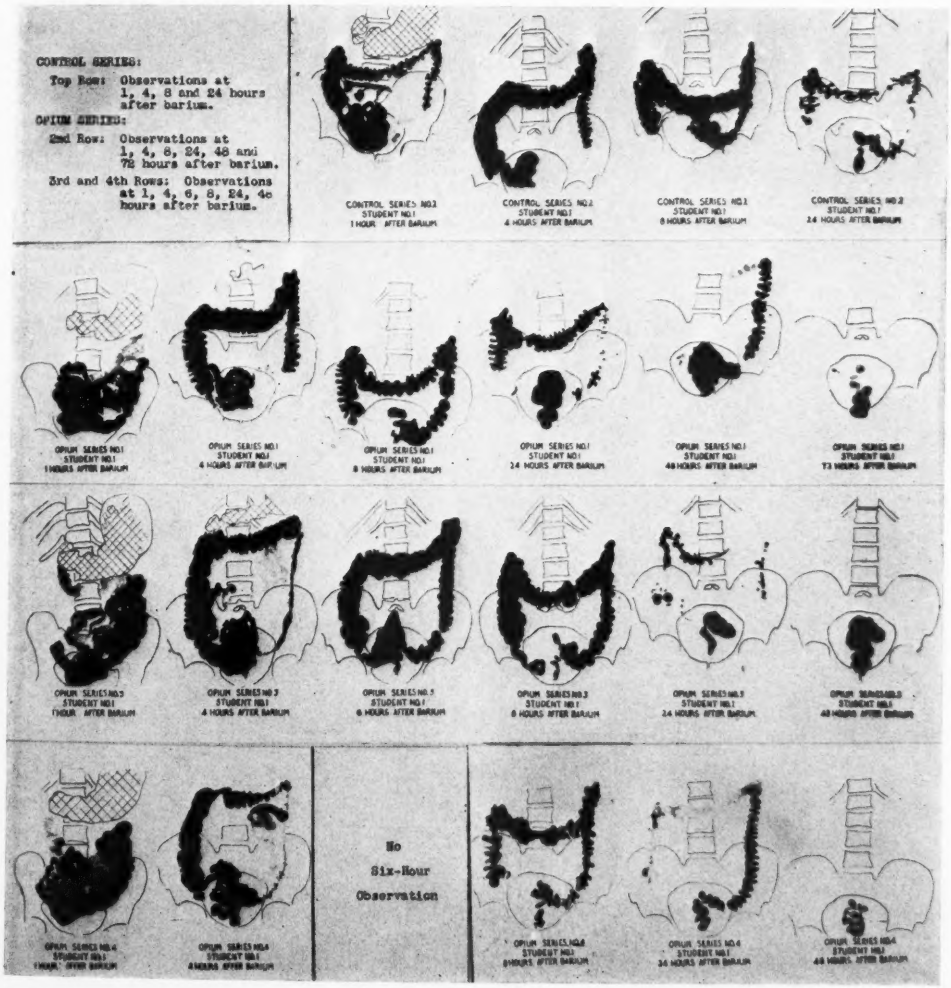


Fig. 1. Student No. 1. Top row: Typical control series; lower three rows: Observations after administration of opium.

In a manner similar to that preceding the taking of barium by mouth, each enema succeeded the taking of three pills. The purpose was to determine, if possible, the resistance or patency of the ileocecal valve following the administration of opium. In contrast to the control series, there was no noticeable difference in the action of the ileocecal valve after opium was given.

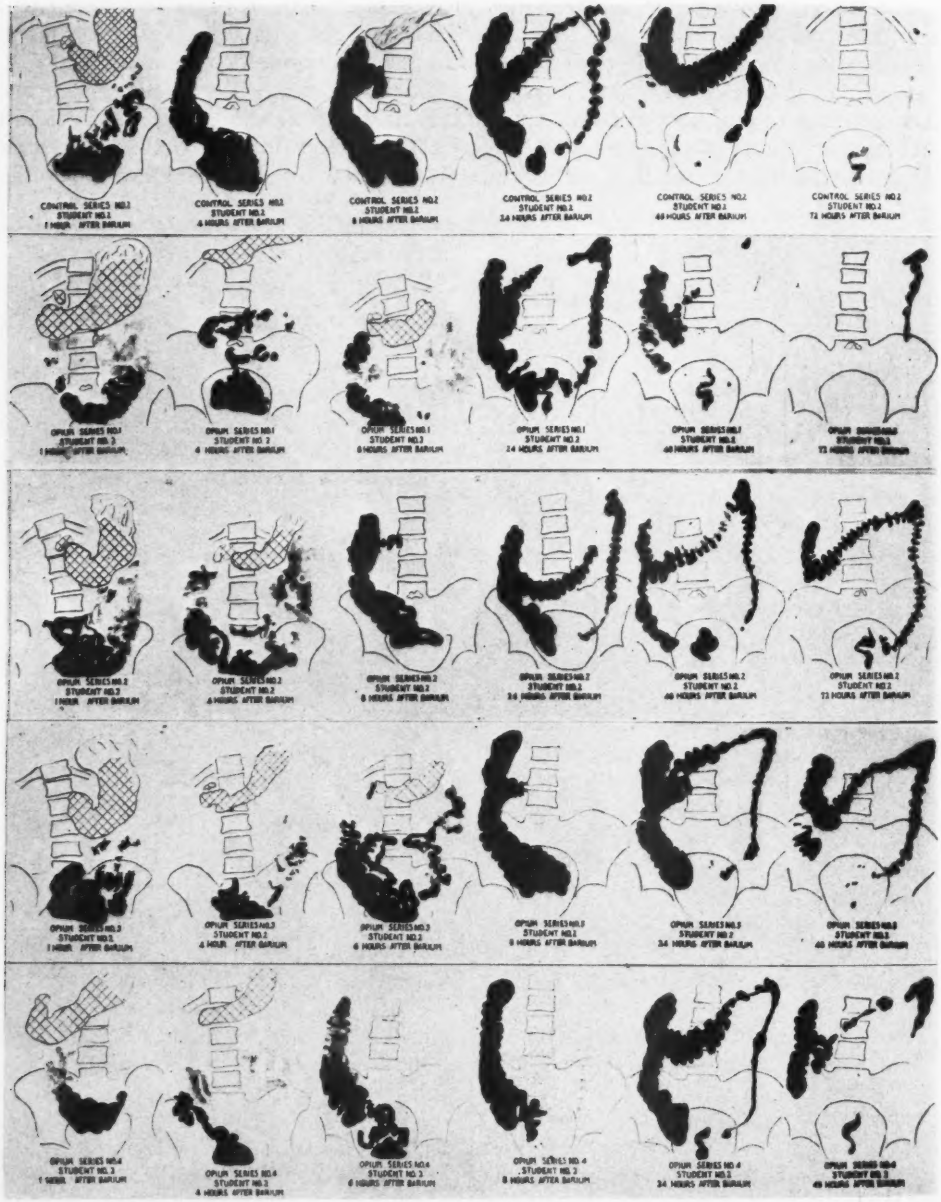


Fig. 2. Student No. 2. Top row: Typical control series; lower four rows: Observation after administration of opium.

SUMMARY

Repeated x-ray studies of the gastro-intestinal tracts of three healthy young adult males during the administration of opium led to the following conclusions as to the action of the drug:

1. No characteristic delay in the emptying time of the stomach.
2. An apparent slowing of the barium

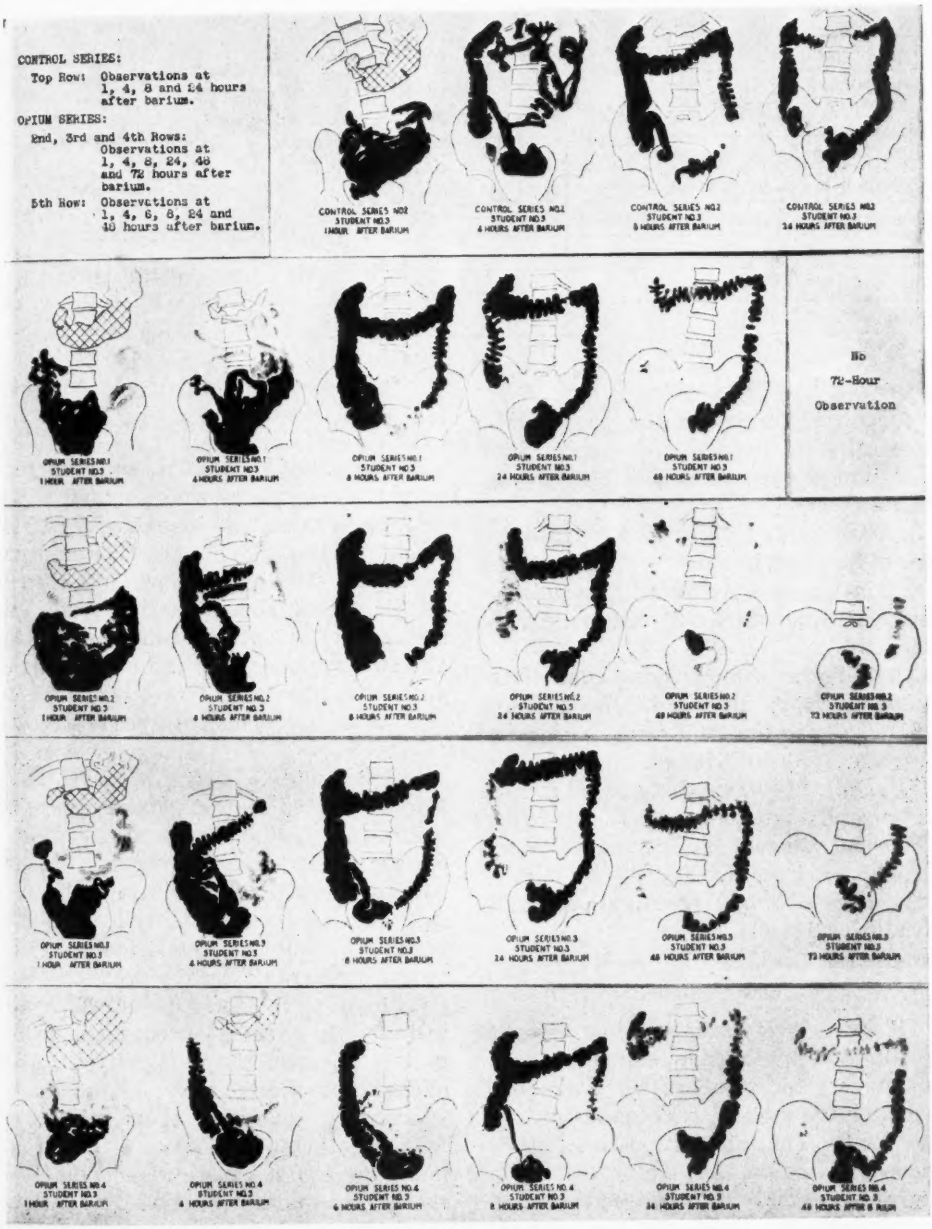


Fig. 3. Student No. 3. Top row: Typical control series; lower four rows: Observations after administration of opium.

SUMMARY OF AVERAGES

	Averages for Control Series			Averages for Opium Series		
	Student			Student		
	No. I	No. II	No. III	No. I	No. II	No. III
	Hours			Hours		
Emptying time of the stomach	4+	8+	8+	6	8+	7
Emptying time of small bowel	8	24	8+	8	24	8+
Barium first seen in cecum	1	4	4	4	5	4
Emptying time of ascending colon	24+	41	48	48	72	56
Barium first seen in transverse colon	1	13	5	4	16	6
Emptying time of transverse colon	48	72	48	56	78	72
Barium first seen in descending colon	1.7	24	7	4	24	8
Barium first seen in rectum	15	24	8	5	24	12
Complete emptying of bowel	54	80	63	80	84	84

in the upper portion of the small bowel, as revealed by an increased concentration of barium in that portion (a feathery appearance).

3. No marked delay in the emptying time of the small bowel.

4. Increased rate of motility in the large bowel of Student No. 1, but not in the other two.

5. Delay in the emptying time of the ascending colon from eight to 31 hours.

6. Delay in the total emptying time of bowel from four to 26 hours.

7. Difficulty in expelling stools in spite of increased desire to defecate.

8. The action of the ileocecal valve was uninfluenced by opium.

9. Opium caused constipation, small, dry and hard stools.

CONCLUSIONS

This work suggests that opium produces constipation by causing difficulty in the expelling of the stools rather than direct action on the motility of the gastro-intestinal tract. The difficult defecation depends perhaps on the hardness and dryness of the stools or on increased tone of the anal sphincters. The problem requires more investigation.

APPENDIX

As a result of fluoroscopic and roentgenographic observations on 23 normal adults, Zehbe concluded that opium's most marked effect is on the large bowel. The emptying time of the stomach and small intestine was lengthened by about one-third; the total sojourn in the entire bowel was doubled. It was his opinion that the cecum was the portion of the large bowel most affected (2). Similar conclusions were reported by Mahlo (3).

Stierlen and Schapira, working on 18 subjects, stated that, in general, morphine, opium, and pantopon have the same effects on the gastro-intestinal tract. In over half their series the motility of the small intestine was retarded while the large bowel was but slightly influenced. The stomach reacts differently to the opiates. In the young it decreases its activity but in adults the effect is less constant. These writers question the possibility of spasm of the ileocecal valve (4).

Schapira concludes that constipation following therapeutic doses of opium and morphine is not explained adequately by the effects on the stomach and intestine (5). He suggests that this may be due to a delayed or suppressed defecating reflex.

According to Pancoast and Hopkins, in most cases the influence of morphine on humans causes a more or less pyloric spasm, increased peristalsis, and a decided prolongation of the emptying time of the gastric contents. An hour-glass contraction was observed. Pancoast and Hopkins say (6):

"In the small intestine, morphine causes decreased motility almost uniformly, apparently as a result of a lack of propulsion and not of spasm. When marked, it is most noticeable in the upper small bowel. The effect on the large bowel is very variable and probably of little consequence."

Plant and Miller found that the action of the alkaloids of opium produce similar results and similar effects on both dog and man. The stomach shows a fall in muscular tone and less peristaltic activity, while the small and large bowel show increase in muscle tone and peristaltic activity. These authors claim that defecation produced by morphine in dogs is due to the marked increase in tone in the sigmoid and rectum which results in a stool if the lower bowel is full. They believe constipation is due to relaxation of the stomach wall and decrease in peristalsis (7).

According to Macht, the most striking effect of morphine is on the stomach, causing pylorospasm. Opium does not produce such a powerful spasm. He also noted similar contraction of the ileocecal valve (8).

Magnus, experimenting with cats, concluded that the most pronounced effect of morphine was on the stomach, especially the pyloric region, while the small and large bowel were scarcely affected (9).

BIBLIOGRAPHY

(1) Cushny: Pharmacology and Therapeutics.
(2) Zehbe: Ther. Mon, **27,** 406, 1913.
(3) Mahlo: Deutsche Arch. f. klin. Med., **110,** 562, 1913.
(4) Stierlen and Schapira: München. med. Wchnschr., **50,** 2714, 1912.
(5) Schapira: Pflüger's Arch. f. Physiol., **151,** 65, 1913.
(6) Pancoast and Hopkins: Jour. Am. Med. Assn., **65,** 1915.
(7) Plant and Miller: Jour. Pharm. Exp. Ther., **27,** 1926; **32,** 413–435, April, 1928.
(8) Macht: Am. Jour. Med. Sci., **154,** 874, 1917.
(9) Magnus: Arch. ges. Physiol., **115,** 316, 1906.

THE DEVELOPMENT OF HIGH VOLTAGE X-RAY TUBES AT THE CALIFORNIA INSTITUTE OF TECHNOLOGY[1]

By CHARLES C. LAURITSEN, California Institute of Technology, *Pasadena, California*

THE difficulties encountered in constructing x-ray tubes for operation at voltages above two or three hundred kilovolts are well known. Stray charges may accumulate on the envelope in such a manner that a dangerously high potential is applied through the wall, with the result that it is punctured. Punctures may also result from tiny pieces of metal torn out of the electrodes by the intense electric fields. Gas may be liberated by stray bombardment caused by the field and resulting in destructive discharges.

These difficulties may be at least partly eliminated by several means. We have attempted to decrease the stray discharges by using electrodes with large curvature and large spacing, so as to decrease as far as possible the field strength at the surfaces. In addition, the glass or other envelope is protected against stray discharges and excessive potentials by proper subdivision and shielding, and any gas which may be liberated during operation is quickly removed by fast pumping.

The first tube to be used for experimental x-ray work at potentials in excess of 300 kv. was constructed in 1928. This tube was operated intermittently at 750 kv. peak, and cold emission was depended on for the source of electrons. Figure 1 shows a section through this tube which is mounted in a temporary wooden structure. The potential is applied between the long inner electrode and the bottom plate, which is at ground potential. It will be noted that the glass wall is nowhere exposed to the full potential and that it is thoroughly protected against stray bombardment.

It was a simple matter to equip this tube with suitable filament and to provide adequate protection for operation and observation at close range. Continuous operation

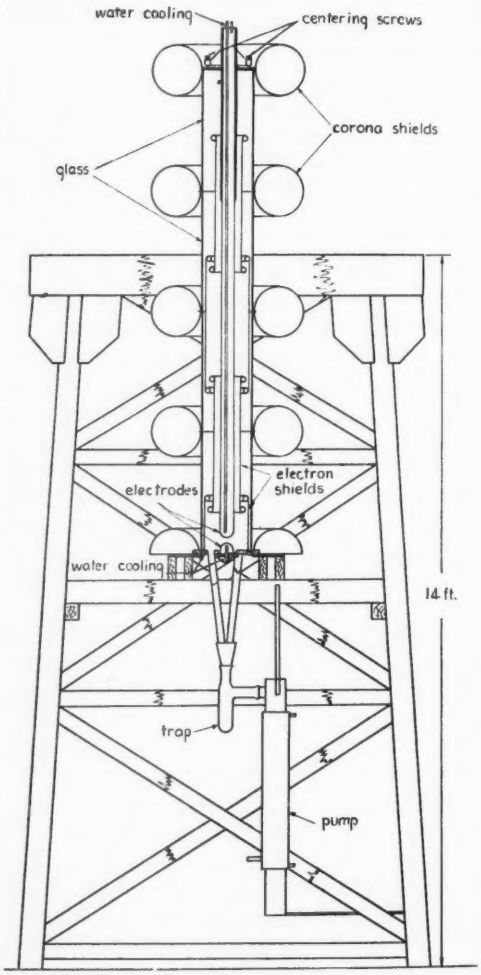


Fig. 1. Sketch of the tube.

was obtained at 600 kv. peak and from 4 to 5 ma. electron emission. Such a tube is shown in Figure 2.

Since no equipment of comparable voltage was at the time available elsewhere, it seemed highly desirable that an attempt be made to learn if x-rays produced at such high potentials are in any respect superior to other forms of radiation for the treat-

[1] Read before the Fifth International Congress of Radiology, at Chicago, Sept. 13–17, 1937.

ment of malignant disease. After much preliminary work with animals and many consultations with men of high standing in the medical profession, it was decided to treat selected cases of advanced deep-seated malignant tumors. Treatment was started in October, 1930, and has been continued up to the present time. In 1931, Mr. W. K. Kellogg became interested in the work and generously provided funds for erecting and equipping a new laboratory to be devoted to clinical research in radiation. The laboratory and a new tube, designed to operate at 1,000 kv., were completed the same year, but actual operation of the plant was delayed for nearly a year due to difficulties in design and construction of the transformers, and regular treatment did not begin until September, 1932. Since that time this equipment has been in daily use for the treatment of malignant disease. During the first year, measurements of output and absorption were made up to 1,200 kv. and the treatment voltage was increased in steps from 600 to 1,000 kv. Since October, 1933, treatment has been carried out uniformly at 900 kv., 3 ma., and 6 mm. steel plus 1 mm. lead filter.

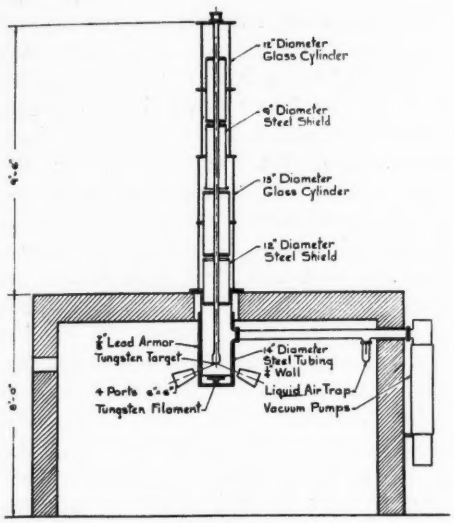


Fig. 2.

It will be seen from Figure 3 that this tube consists essentially of two of the older tubes placed end to end. Each end is connected to its own transformer and the central section, which is at ground potential, extends through the treatment room.

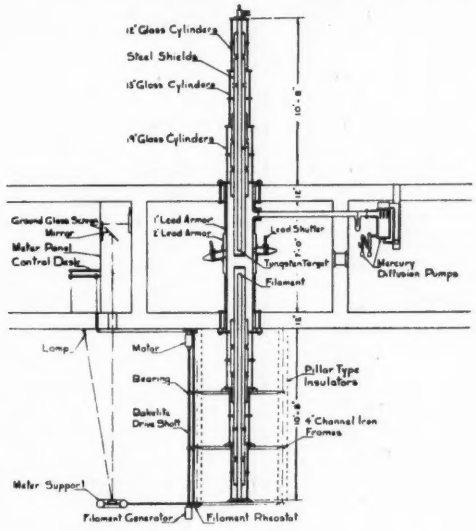


Fig. 3.

The tubes described so far were all constructed from commercially available glass cylinders which were easily obtainable and inexpensive. Although this construction has proved very simple and entirely satisfactory, it occurred to us that porcelain might be even more suitable for the purpose. It is readily produced with comparatively thick walls, thus providing greater strength both mechanically and electrically. If the walls are deeply corrugated, the total length may be somewhat decreased for a given potential. Such a tube was operated successfully up to 650 kv. peak and was described in 1933. As Figure 4 shows, the construction is extremely simple.

Comparison between Low and High Voltage Radiation.—A discussion of the optimum voltage for use in deep therapy is likely to become very complicated, for the answer depends on a large number of factors, some of which are not well understood.

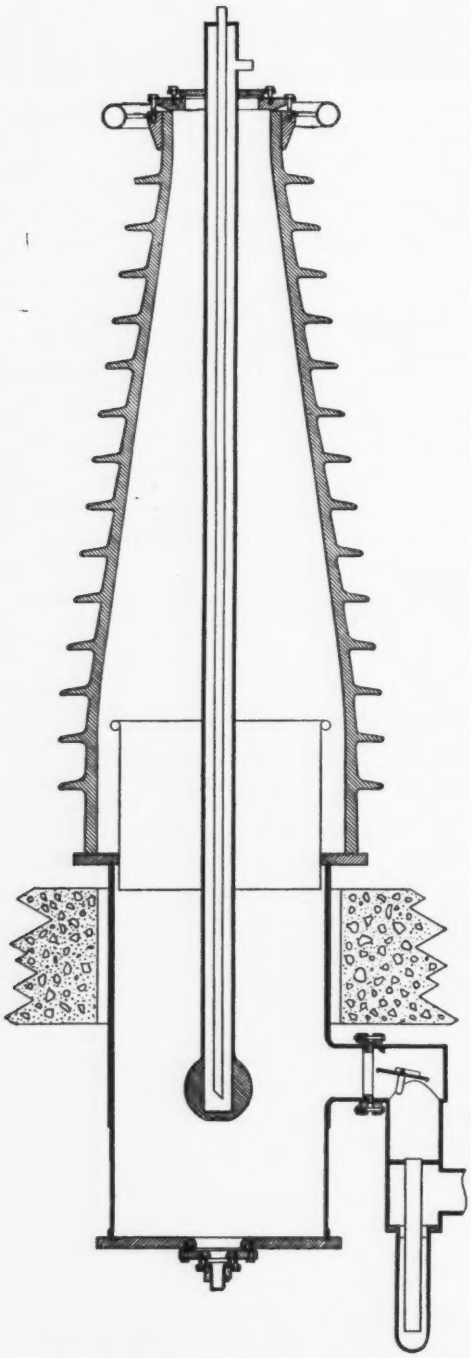


Fig. 4.

Nevertheless, it may be profitable to discuss the question in a qualitative way. The optimum voltage may possibly depend on a differential wave length effect, but on this point we are still in almost complete ignorance. If we assume for the moment that no such effect exists, then the action on any tissue must depend solely upon the amount of energy absorbed per cm.^{3} of that tissue, for only the absorbed energy can possibly influence the tissue. Our aim must, therefore, be to obtain the greatest possible absorption of energy per cm.^{3} in the tumor for a given amount of energy absorbed per cm.^{3} in the surrounding and overlying normal tissue. It can be shown on reasonable assumptions that the total energy which can be delivered to a patient through a single large portal increases steadily with increasing tube voltage, when the skin is the limiting factor. This relation is shown in Figure 5 and the increase amounts to a factor of nearly two in going from 200 kv. to heavily filtered 1,000 kv. radiation. But it is not certain that this increase in total energy is always useful or desirable, for we are much more interested in the energy absorbed at a given point than in the energy present or passing through, and the energy absorbed depends not only on how much energy is present but also on the absorbability of the radiation. Therefore, if a certain kind of radiation becomes much more absorbable with increasing depth, we may have a greater dose at a given depth than with radiation which is less rapidly degraded.

Depth Dose.—By "depth dose" we mean the number of ergs absorbed per cm.^{3} at a specified depth when 100 ergs have been absorbed per cm.^{3} at the surface. The depth dose depends on the following factors:

(1) The substance in which the dose is measured;
(2) The wave length of the incident radiation;
(3) The cross-sectional area and shape of the beam;
(4) The distance between the source and the surface.

We shall limit our discussion to substances in which the mechanism of absorption is similar to that in tissue, as, for example, water and paraffin. The dependence on wave length is different for beams of different cross-sectional areas and, therefore, these two effects can best be discussed together.

It is important to keep in mind just what determines how much energy is absorbed and to distinguish clearly between absorption and attenuation. As the x-ray beam penetrates into the substance, the energy density changes, due either to a decrease in the number of quanta or to a decrease in the energy of the individual quanta, or both. This change we refer to as "attenuation" and the factor which governs it we call the "attenuation coefficient." For low voltage radiation, say 50 kv. or less, the attenuation is almost entirely due to a decrease in the number of quanta, but for high voltage radiation the probability that a quantum loses all of its energy in a single collision is negligible, and, therefore, the total number of quanta in a wide beam remains practically constant until the quanta have only some 50 kv. left, and the attenuation is due only to the degradation of the quantum energy. Only that fraction of the energy which is given to the electrons can contribute directly to our measurement, or to any biological effect at the point considered, and, therefore, this fraction is referred to as the true absorption at this point, it being assumed that the range of the electrons is short compared to the volume in which observations are made. This assumption is a reasonable one in water or tissue, but not in air, where the range of electrons from hard radiation may be very great compared to the linear dimensions of the volume in which measurements are made. Failure to recognize the importance of this last fact is responsible for the ambiguity in the existing definition of the roentgen and for the difficulties encountered in expressing gamma radiation in roentgens.

Beam of Small Cross-section.—By a "narrow beam" or "beam of small cross-section" we mean a beam of width small compared to the range of the electrons, while a "wide beam" is one of such dimensions as are comparable to the half value layer in the substance in which the measurement is made. Thus, a 10 × 10 cm. beam of high voltage radiation would be considered narrow in air but wide in water or tissue.

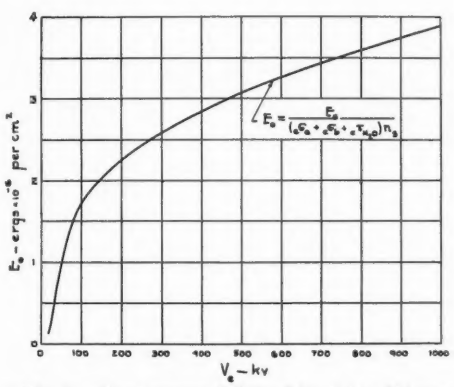


Fig. 5. Total energy delivered for 1.4×10^4 ergs absorbed per cm.^{2} of a surface layer of water 1 mm. thick. V_e = equivalent voltage.

A parallel beam of radiation of infinitely small cross-section is of little therapeutic use, but, unfortunately, it is the only case for which we can obtain a rigorous solution and it is important in measuring dose in roentgens by means of the standard air chamber and also in the determination of half value layers. We shall, therefore, discuss this case in some detail. For such a beam the dose at any depth increases with voltage up to at least twenty or thirty million volts, after which it begins to decrease, due to the increasing probability for the production of positive and negative electron pairs. The measurement of energy absorbed at any depth depends on the energy density at that depth and on the true absorption coefficient. When the beam is narrow the scattered quanta are lost from the beam, due to change in direction, and the energy density is, therefore, determined by the total absorption coefficient, so that in this case the attenuation

coefficient is equal to the total absorption coefficient μ, the value of which is accurately known for all wave lengths. The energy density is, therefore, given by the well known relation $I = I_o e^{-\mu x}$ ergs per

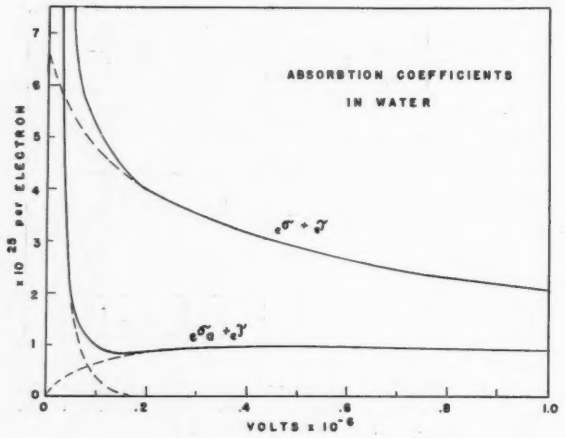


Fig. 6.

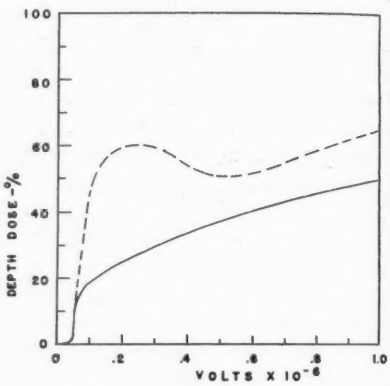


Fig. 7.

cm.^{2} at any depth x below the surface. But the energy absorbed in any thin layer of thickness Δx depends on the true absorption coefficient $(\tau + \sigma_a)$, hence the energy absorbed in this layer is $Q = (\tau + \sigma_a) I_o e^{-\mu x} \Delta x$ ergs per cm.^{3} per second.

If the initial radiation is monochromatic or at least fairly homogeneous, then since the degraded radiation is lost from the beam, the true absorption coefficient as well as the attenuation coefficient remains unchanged with depth and we can calculate Q exactly for this special case.

Beam of Large Cross-section.—A parallel beam of infinitely large cross-section is also not of great therapeutic use and in this case we cannot even make the calculation rigorously, but we can make a rough estimate of the dose at any depth and thus obtain a qualitative insight into the processes involved. It is clear that in this case both the attenuation coefficient and the absorption coefficient depend upon the wave length of the primary radiation and both change with depth, because the scattered radiation which always corresponds to lower voltage than the primary is not lost from the beam and hence contributes to the energy density. Figure 6 shows how the coefficients for total and true absorption vary with energy for monochromatic radiation. The total absorption coefficient is a smooth, slowly varying function of energy, while the true absorption coefficient drops steeply to a minimum at about 100 kv. and then, after rising slightly, remains almost constant for higher energies. The attenuation coefficient cannot be calculated precisely but it must certainly lie between the two curves shown and it is much more like the upper than the lower curve. This radical difference between the two curves is responsible for a peculiar behavior of the depth dose as a function of the voltage of the primary radiation, a behavior which can only be predicted by a careful analysis of the absorption mechanism. If the primary radiation corresponds to 100 or 200 kv., then the attenuation is large but the true absorption is very small, so that we have comparatively little energy absorbed near the surface. But at a greater depth many of the quanta will become much more absorbable although they have lost only a small fraction of their energy. The absorption will, therefore, be comparatively great. On the other

hand, if the primary radiation corresponds to much higher voltage, then the attenuation is considerably smaller, but the true absorption is about the same as before and the degraded quanta do not become more absorbable until they have lost nearly all of their energy. Since the degraded quanta are no more absorbable than the primary we see that the degradation of radiation does not play an important part in the absorption of very high voltage radiation and the radiation does not become much more absorbable with increasing depth.

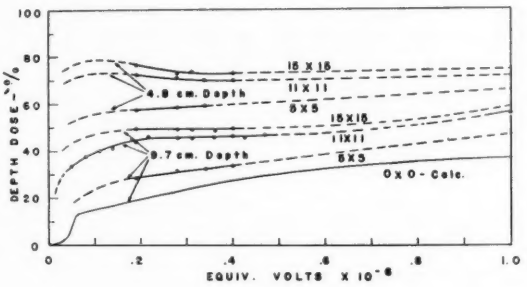


Fig. 8.

Since the depth dose is the ratio of the energy absorbed at a given depth to that absorbed at the surface it is clear that the greatest depth dose is obtained with radiation which becomes more absorbable with increasing depth, provided it is not too strongly attenuated within the distance in which we are interested. Thus, if we start out with a beam of 100 kv. radiation, we have at a depth of 10 cm. approximately 18 per cent of the original radiation left, but, in addition, we have nearly an equal amount of degraded radiation which, because it is much more absorbable, contributes much more to the ionization, so that for very large beams the dose at 10 cm. may approximate 50 per cent. Had we started out with 500 kv. radiation we should have about 37 per cent of the original beam left at 10 cm. but a much smaller contribution from degraded radiation than before, and the depth dose at 10 cm. will still be about 50 per cent. Only at depths much greater than 10 cm. can we expect to find a considerable increase in the depth dose at the higher voltage.

For voltages lower than 100 kv. the dose at 10 cm. depth is low because the attentuation is large and the radiation becomes less absorbable with depth. For radiation of somewhat higher voltage the attenuation is smaller and the radiation becomes more absorbable with depth. Above 1,000 kv. the depth dose will increase steadily with increasing voltage, due to decreased attenuation and to the fact that the absorbability of the radiation changes comparatively little with depth. In Figure 7 is indicated the general trend to be expected at a depth of 10 cm. as a function of voltage. The lower curve gives the calculated dose at 10 cm. for an infinitely small beam, while the upper curve is a rough estimate for a large beam. The curve rises rapidly at first, goes through a maximum somewhat above 100 kv., then drops to a flat minimum above 500 kv., after which it increases rather slowly up to about twenty million volts. We see from this that we may very well expect to obtain a greater dose at 10 cm. with primary radiation from an x-ray tube operated at from 400 to 500 kv. than with radiation produced at either lower or somewhat higher voltage, provided very large portals are used; this, in spite of the fact that the energy density may be considerably greater in the case of the higher voltage.

These considerations are, of course, strictly applicable only for monochromatic primary beams. With heterogeneous radiation, the maximum and minimum will be less pronounced and the curve will be considerably smoother. For beams of limited cross-section such as are used in therapeutic work, the curves lie between these two extremes. Some examples of actual measurements are shown in Figure 8. In all cases we find a rapid increase below 100 kv. and only for beams of very small cross-section is an increase to be expected between 200 and 500 kv., that is, for tube voltages between 500 and 1,000 kv. For beams larger than 10 × 10 cm. we can expect no increase and possibly a decrease in this region. This means that if we want a greater dose at 10 cm. when beams of cross-section greater than 10 × 10 cm. are used, we must operate x-ray tubes at voltages considerably above 1,000 kv. From this point of view alone there is thus a considerable gain in increasing the voltage up to 400 or 500 kv., but no further advantage is obtained by an increase from 500 to 1,000 kv. On the other hand, if we are interested in the dose at depths greater than 10 cm. or if it is desired to use beams smaller than 10 × 10 cm., then the gain above 500 kv. is noticeable and continuous.

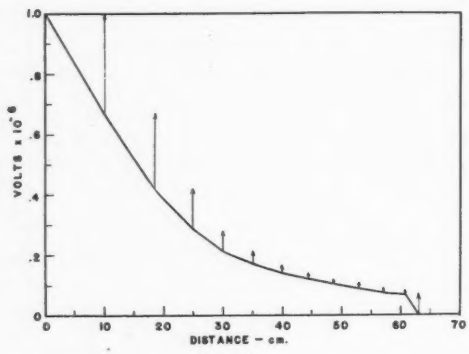


Fig. 9.

Focal Skin Distance.—It is tempting but not very profitable to attempt to increase the depth dose by increasing the distance between the source and the surface. Apart from the great sacrifice in intensity, there are two serious difficulties which are often overlooked. One is that any increase in distance results in an exactly corresponding increase in surface area covered for a given area in the depth, and hence in cases in which we are limited by the available skin area we shall precisely defeat our purpose. In practical application this is, of course, not always relevant and the increased distance may not result in a decrease in the number of portals available for treatment, but even then the actual gain is not nearly as large as would be supposed from a naïve application of the inverse square law, especially when the x-ray tube is operated at 200 or 300 kv. The reason for this is that in this case only about one-third of the absorption at 10 cm. depth is due directly to the primary radiation and it is only this third which is immediately subject to change with distance. The scattered radiation, which contributes two-thirds to the absorption, is comparatively unaffected by the focal skin distance, and hence the observed increase in depth dose is likely to be at most one-third of the expected increase.

Possible Differential Effect.—The possibility of a differential effect varying with wave length can neither be proved nor ruled out on purely physical grounds, but it does not seem impossible that biological effects may depend at least to some extent on the range of the electrons produced by the radiation. It is a simple matter to determine the average range of the electrons produced by any given kind of primary radiation. This can be illustrated by considering the most probable course of events when a high energy quantum is completely absorbed. In Figure 9 is shown the most probable energy losses for a 1,000 kv. quantum. The abscissa shows the distance in which the probability is one-half that the quantum makes a collision with an electron. The ordinate indicates the most probable energy division between electron and quantum. It is seen that on the average about one-third of the total energy of a 1,000 kv. quantum is given to the electron, while the remainder constitutes a new

quantum with a considerable change in direction. In subsequent collisions the quantum energy is further decreased, but each time the fraction given to the electron becomes smaller until, when the quantum has some 50 to 100 kv. of energy left, it loses all of this in a single encounter. It is seen that as the energy is changed from 100 to 200 kv., that is, as the tube voltage is increased from 200 to 400 kv., no appreciable change occurs in the energy and range distribution of the electrons. We should, therefore, not expect any change in biological effect in this region. On the other hand, when the tube voltage is increased to 500 kv. or more, some electrons with very much higher energy and, therefore, greater range will be produced, and this may possibly give rise to a change in biological effect. Whether this change is for better or worse cannot be predicted from our present knowledge.

CASE REPORTS

PRIMARY CARCINOMA OF THE THIRD PORTION OF THE DUODENUM

By SIMON POLLACK, M.D., *Chicago*

From the Cook County Hospital, Department of Roentgenology, M. J. Hubeny, M.D., Director

The clinical differentiation of lesions of the duodenum and the structures adjacent to it has always been a difficult problem, but one whose solution in recent years has been greatly facilitated by careful roentgen examination.

Carcinoma of the duodenum is one of the rarer of this group of lesions and one which may, in most cases, be diagnosed by careful routine examination of the *whole* duodenum, both by fluoroscopy and films. The findings of (1) filling defect, (2) irregularity of the mucosal pattern, or (3) obstruction to the duodenum which remain constant, are strongly indicative of a possible malignant tumor. If such findings are repeatedly demonstrable, the probability of the presence of a duodenal neoplasm is stronger yet.

Recently numerous authors have reported series of carcinomas of the small intestine or the duodenum based on postmortem or surgical material. Raiford (1), in a review of 11,500 postmortem and 45,000 surgical cases at Johns Hopkins Hospital, found 88 tumors, both benign and malignant, of the small intestine. Of these, 21 were located in the duodenum and only seven were carcinomatous. Doub and Jones (2) in 1936 reported 15 cases of primary malignancy of the small bowel, nine of which were carcinomas of the duodenum.

Weintraub and Tuggle (3), in reporting 20 cases of carcinoma involving the duodenum, included two cases of primary duodenal carcinoma, and two cases of carcinoma of the ampulla of Vater. These cases were diagnosed roentgenologically.

C. I. Allen (4), in a recent analysis of eleven cases of primary carcinoma of the duodenum, discusses their incidence, diagnosis, and surgical treatment. Eleven cases were proven in a series of 143,613 admissions in the past ten years, an incidence of about 1 in 14,000 cases. Seven of his cases were carcinomas of the ampulla of Vater, two were suprapapillary, and two infrapapillary. In four cases, roentgenologic evidence of a duodenal lesion was reported, and in only three cases was a correct pre-operative diagnosis made of duodenal or ampullary carcinoma.

Our case, reported below, is of interest because of the rarity of the lesion, its pre-operative roentgenologic diagnosis, and surgical corroboration of this diagnosis.

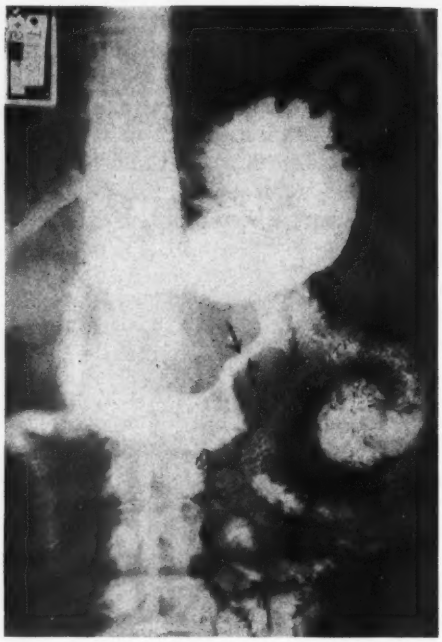


Fig. 1. Roentgenogram after barium meal revealing an annular filling defect of the third portion of the duodenum as outlined by the arrows.

CASE REPORT

L. N., white female, aged 47, entered the Cook County Hospital, Feb. 14, 1938. Entrance Room Diagnosis: old case of cholecystitis.

History.—In May, 1937, this patient began to vomit one-half hour after her evening meal. Soon she began to notice she would also vomit some days about 10 A.M. After Christmas, the vomiting had become more frequent and annoying. Although the emesis would follow intake of any type of food, she has had a long-standing selective dyspepsia for meats, potatoes, gravy, and cabbage.

Pain in the left upper quadrant, boring into the back, has also been noted since the onset of the vomiting.

Stools have been loose in consistency, sometimes watery, but no undigested food particles or blood were noted in the excreta. She would have four or five such bowel movements a day. No history of tarry stools was elicited.

Past History.—Medical: pleurisy; following childbirth caked breast, 27 years ago. Surgical: Herniotomy, 37 years ago; "female trouble," 18 years ago (perineorrhaphy); "tu-

mor of womb," 13 years ago. Para VI-Grav. VIII (two self-induced abortions). No family history of carcinoma.

Physical Examination.—Essentially negative, except for tenderness in the epigastrium. No abdominal masses were palpated.

Work-up.—Stools: three plus for chemical blood on three occasions; contained fat and fatty acids when stained with sudan three.

Glucose tolerance test: shows tendency to a diabetic curve.

Serum amylase: 55 units per 100 c.c. serum.

Ewald: 0 free—18 total: 0 free—5 total.

Blood: hemoglobin, 85 per cent; red blood cells, 3,940,000; white blood cells, 5,000.

Urine: negative.

Graham-Cole test: faint visualization of the gall bladder.

Colon: X-ray No. 14922—marked spasticity of the descending and sigmoid colon, with evidence of diverticula.

Stomach: X-ray Nos. 11724, 15255, 16366—all showed an annular defect of the third portion of the duodenum, rigid and fixed.

Diagnosis.—Primary carcinoma of the duodenum.

Surgery.—March 3, 1938, exploratory laparotomy by Dr. P. Rosi revealed a firm stenosing carcinoma of the third portion of the duodenum. A posterior gastro-enterostomy was done.

April 2, 1938, an attempt was made to resect the tumor, but this was not done as it was fixed to the root of the mesentery and to the superior mesenteric artery.

Additional Note.—Since this article was written there has appeared a report of a practically identical case by L. N. Claiborn and W. G. H. Dobbs in Surgery, **4,** 97, July, 1938.

BIBLIOGRAPHY

(1) RAIFORD, T. S.: Tumors of the Small Intestine: Their Diagnosis, with Special Reference to the X-ray Appearance. RADIOLOGY, **16,** 253–270, February, 1931.

(2) DOUB, H. P., and JONES, H. C.: Primary Malignant Tumors of the Small Intestines. RADIOLOGY, **26,** 209–220, February, 1936.

(3) WEINTRAUB, S., and TUGGLE, A.: Neoplasms Involving the Duodenum. RADIOLOGY, **28,** 362–364, March, 1937.

(4) ALLEN, C. I.: Primary Carcinoma of the Duodenum. Am. Jour. Surg., **40,** 89–101, April, 1938.

SLIPPING SACRO-ILIAC JOINTS[1]

By I. S. TROSTLER, M.D., F.A.C.R., F.A.C.P.,
Chicago

The verity or actuality of the slipping of sacro-iliac joints is disputed and denied by many, questioned by more, and admitted by a few clinical anatomists. I admit being one of the latter few.

I have used a simple method of demonstrating and proving that sacro-iliac joints can and do slip an appreciable and measurable distance, and having by this method been enabled to convince a considerable number of insurance adjusters, medical referees, attorneys, courts, and juries during the last twenty-five years, it occurred to me recently to search the literature to determine if the method I have been using had been published. Being unable to find any previous publication, I will give it to you for whatever you think it is worth, and demonstrate a case by two roentgenograms.

The technic is as follows: Place the patient supine on the table and allow her to move and wiggle about until her back is comfortable. Then expose the film. Next have the patient walk about and, if necessary, carry a weight (a nine-pound bag of sand is my usual weight) until the spinal discomfort appears, after which *expose a second film with the patient erect and the tube in exactly the same relation to the pelvis as before* (*in the first film*).

If now, after the films are dry, lines are drawn across the upper borders of the ilii and the sacri (see Figs. 1 and 2), it will be seen that the lines are nearly if not quite parallel on the film made with the patient supine, and divergent from the normal side in the film made when the patient was erect, if one side only has slipped. If both sacro-iliac joints slip, the distance between the lines will, of course, be greater in the film made with patient erect. Any difference in the outline of the curve of the iliac crest projected upon the film is accounted for by the difference in the tilting of the patient's pelvis in the two postures; but this difference in pelvic tilt cannot and will not account for a change in the relation between the ilii and sacri at the sacro-iliac joints.

This method is also useful to demonstrate the degree of movability in movable kidneys.

I have used this method—or films made by this method—in several instances in which legal controversy hinged upon the question of slipping of this joint, and have found that it is most convincing, even to expert witnesses who

[1] Presented before the Chicago Roentgen Society, May 12, 1938.

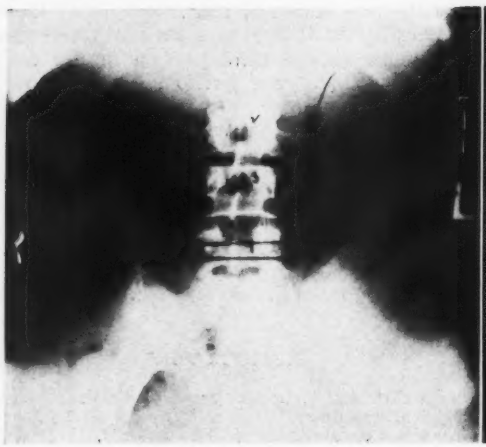


Fig. 1. Patient supine. Note difference in position of left kidney. Normal.

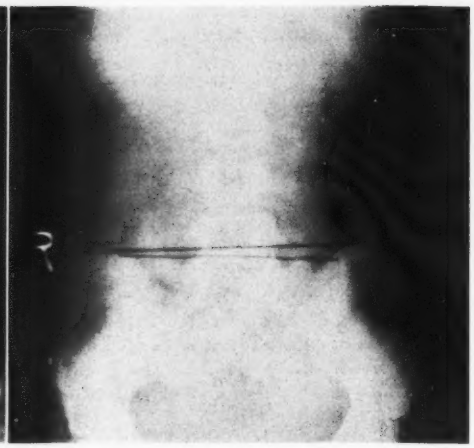


Fig. 2. Patient erect. Note difference in position of left kidney. Ptosed.

came into court to testify against the party to the suit that had called me. When it is necessary to show films made by this method, a bony pelvis should be at hand so as to illustrate exactly what the shadows in the films demonstrate. In that manner it is easy to prove to a lay jury and I have even had attorneys for the defendants ask to have the procedure explained to them.

Note.—The difference in the density and contrast in these two films is caused by the use of the Potter-Bucky diaphragm in the film made in the supine posture and its non-use in the erect posture.

RADIOLOGICAL SOCIETIES IN THE UNITED STATES

Editor's Note.—Will secretaries of societies please cooperate with the Editor by supplying him with information for this section? Please send such information to Leon J. Menville, M.D., 1201 Maison Blanche Bldg., New Orleans, La.

CALIFORNIA

California Medical Association, Section on Radiology.—Chairman, John D. Lawson, M.D., 1306 California State Bldg., Sacramento; *Secretary,* Karl M. Bonoff, M.D., 1930 Wilshire Blvd., Los Angeles. Meets annually with California Medical Association.

Los Angeles County Medical Association, Radiological Section.—President, John F. Chapman, M.D., 65 N. Madison Ave., Pasadena; *Vice-president,* E. N. Liljedahl, M.D., 1241 Shatto St.; *Secretary,* Merl L. Pindell, M.D., 678 South Ferris Ave.; *Treasurer,* Henry Snure, M.D., 1414 Hope Street. Meets every second Wednesday of month at County Society Building.

Pacific Roentgen Club.—At its recent Annual Meeting at Pasadena, the following officers were elected for the ensuing year: *Chairman,* Lyell C. Kinney, M.D., San Diego; *Member of the Executive Committee,* Irving S. Ingber, M.D., San Francisco; *Secretary-Treasurer,* L. Henry Garland, M.D., Suite 1739, 450 Sutter Street, San Francisco. The other members of the Executive Committee are: Lowell S. Goin, M.D., Los Angeles, and Alfred C. Siefert, M.D., Oakland.

San Francisco Radiological Society.—Secretary, L. H. Garland, M.D., 450 Sutter Street. Meets monthly on first Monday at 7:45 P.M., alternately at Toland Hall and Lane Hall.

COLORADO

Denver Radiological Club.—President, John S. Bouslog, M.D., 246 Metropolitan Bldg.; *Vice-president,* Sanford Withers, M.D., 304 Republic Bldg.; *Secretary,* Ernst A. Schmidt, M.D., Colorado General Hospital; *Treasurer,* H. P. Brandenburg, M.D., 155 Metropolitan Bldg. Meets third Tuesday of each month at homes of members.

CONNECTICUT

Connecticut State Medical Society, Section on Radiology.—Chairman, Ralph T. Ogden, M.D., 179 Allyn St., Hartford; *Vice-chairman,* Francis M. Dunn, M.D., 100 State Street, New London; *Secretary-Treasurer,* Max Climan, M.D., 242 Trumbull St., Hartford. Meetings twice annually in May and September.

DELAWARE

Affiliated with Philadelphia Roentgen Ray Society.

FLORIDA

Florida State Radiological Society.—President, H. O. Brown, M.D., 404 First National Bank Bldg., Tampa; *Vice-president,* H. B. McEuen, M.D., 126 W. Adams St., Jacksonville; *Secretary-Treasurer,* J. H. Lucinian, M.D., 168 S. E. 1st St., Miami.

GEORGIA

Georgia Radiological Society.—President, James J. Clark, M.D., Doctors Bldg., Atlanta; *Vice-president,* William F. Lake, M.D., Medical Arts Bldg., Atlanta; *Secretary-Treasurer,* Robert C. Pendergrass, M.D., Prather Clinic, Americus. Meetings twice annually, in November and at the annual meeting of the Medical Association of Georgia in the spring.

ILLINOIS

Chicago Roentgen Society.—President, David S. Beilin, M.D., 411 Garfield Ave.; *Vice-president,* Chester J. Challenger, M.D., 3117 Logan Blvd.; *Secretary-Treasurer,* Roe J. Maier, M.D., 7752 Halsted St. Meets second Thursday of each month, September to May, except December.

Illinois Radiological Society.—President, Cesare Gianturco, M.D., 602 W. University Ave., Urbana; *Vice-president,* Fred H. Decker, M.D., 802 Peoria Life Bldg., Peoria; *Secretary-Treasurer,* Edmund P. Halley, M.D., 968 Citizens Bldg., Decatur. Meetings quarterly by announcement.

Illinois State Medical Society, Section of Radiology.—President, Roswell T. Pettit, M.D., 728 Columbus St., Ottawa; *Secretary,* Ralph G. Willy, M.D., 1138 N. Leavitt St., Chicago.

INDIANA

Indiana Roentgen Society.—President, Stanley Clark, M.D., 108 N. Main St., South Bend; *President-elect,* Juan Rodriguez, M.D., 2903 Fairfield Ave., Fort Wayne; *Vice-president,* A. C. Holley, M.D., Attica; *Secretary-Treasurer,* Clifford C. Taylor, M.D., 23 E. Ohio St., Indianapolis. Annual meeting in May.

IOWA

The Iowa X-ray Club.—Holds luncheon and business meeting during annual session of Iowa State Medical Society.

MAINE

See New England Roentgen Ray Society.

MARYLAND

Baltimore City Medical Society, Radiological Section.—Chairman, Marcus Ostro, M.D., 1810 Eutaw Place; *Secretary,* H. E. Wright, M.D., 101 W. Read St., Baltimore. Meetings second Tuesday of each month.

MASSACHUSETTS

See New England Roentgen Ray Society.

MICHIGAN

Detroit X-ray and Radium Society.—President, E. W. Hall, M.D., 10 Peterboro Street; *Vice-president,*

Sam W. Donaldson, M.D., 326 North Ingalls St., Ann Arbor; *Secretary-Treasurer*, E. R. Witwer, M.D., Harper Hospital. Meetings first Thursday of each month from October to May, inclusive, at Wayne County Medical Society Bldg.

Michigan Association of Roentgenologists.—President, E. R. Witwer, M.D., Harper Hospital, Detroit; *Vice-president*, D. W. Patterson, M.D., 622 Huron Street, Port Huron; *Secretary-Treasurer*, C. K. Hasley, M.D., 1429 David Whitney Bldg., Detroit.

MINNESOTA

Minnesota Radiological Society.—President, Walter H. Ude, M.D., 78 S. 9th St., Minneapolis; *Vice-president*, Leo G. Rigler, M.D., University Hospitals, Minneapolis; *Secretary-Treasurer*, Harry Weber, M.D., 102 Second Ave., S. W., Rochester. Meetings quarterly.

MISSOURI

The Kansas City Radiological Society.—President, L. G. Allen, M.D., 907 N. 7th St., Kansas City, Mo.; *Secretary*, Ira H. Lockwood, M.D., 306 E. 12th St., Kansas City, Mo. Meetings last Thursday of each month.

The St. Louis Society of Radiologists.—President, Joseph C. Peden, M.D., 634 N. Grand Blvd.; *Secretary*, W. K. Mueller, M.D., 607 N. Grand Blvd. Meetings fourth Wednesday of each month.

NEBRASKA

Nebraska Radiological Society.—President, E. W. Rowe, M.D., 128 N. 13th St., Lincoln; *Secretary*, D. Arnold Dowell, M.D., 117 S. 17th St., Omaha. Meetings first Wednesday of each month at 6 P.M. in Omaha or Lincoln.

NEW ENGLAND ROENTGEN RAY SOCIETY

(Maine, New Hampshire, Vermont, Massachusetts, and Rhode Island.) *President*, Frank E. Wheatley, M.D., 520 Beacon St., Boston; *Secretary*, E. C. Vogt, M.D., 300 Longwood Ave., Boston. Meetings third Friday of each month from October to May, inclusive, usually at Boston Medical Library.

NEW HAMPSHIRE

See New England Roentgen Ray Society.

NEW JERSEY

Radiological Society of New Jersey.—President, Milton Friedman, M.D., Newark Beth Israel Hospital, Newark; *Vice-president*, P. S. Avery, M.D., 546 Central Ave., Bound Brook; *Secretary*, W. James Marquis, M.D., 198 Clinton Ave., Newark; *Treasurer*, James Boyes, M.D., 744 Watchung Ave., Plainfield. Meetings at Atlantic City at time of State Medical Society, and Midwinter in Newark as called by president.

NEW YORK

Brooklyn Roentgen Society.—President, Albert Voltz, M.D., 115–120 Myrtle Avenue, Richmond Hill; *Vice-president*, A. L. L. Bell, M.D., Long Island College Hospital, Henry, Pacific, and Amity Sts., Brooklyn; *Secretary-Treasurer*, E. Mendelson, M.D., 132 Parkside Ave., Brooklyn. Meetings first Tuesday in each month at place designated by president.

Buffalo Radiological Society.—President, Walter Mattick, M.D., 101 High St.; *Vice-president*, Chester Moses, M.D., 333 Linwood Ave.; *Secretary-Treasurer*, J. S. Gian-Franceschi, M.D., 610 Niagara Street. Meetings second Monday evening each month.

Central New York Roentgen-ray Society.—President, W. E. Achilles, M.D., 60 Seneca St., Geneva; *Vice-president*, M. T. Powers, M.D., 250 Genesee St., Utica; *Secretary-Treasurer*, Carlton F. Potter, M.D., 425 Waverly Ave., Syracuse. Meetings held in January, May, and October as called by Executive Committee.

Long Island Radiological Society.—President, David E. Ehrlich, M.D., 27 W. 86th St., New York City; *Vice-president*, H. Koiransky, M.D., 43–37 47th St., Long Island City; *Secretary*, S. Schenck, M.D., 115 Eastern Parkway, Brooklyn; *Treasurer*, Moses Goodman, M.D., 45–01 Skillman Ave., Long Island City. Meetings fourth Thursday evening each month at Kings County Medical Bldg.

New York Roentgen Society.—President, Raymond W. Lewis, M.D., 321 E. 42nd St., New York City; *Vice-president*, Henry K. Taylor, M.D., 667 Madison Ave., New York City; *Secretary*, Roy D. Duckworth, M.D., 170 Maple Ave., White Plains; *Treasurer*, Eric J. Ryan, M.D., St. Luke's Hospital, New York City; *Member of Executive Committee*, E. Forrest Merrill, M.D., 30 W. 59th St., New York City. Meetings third Monday evening each month at Academy of Medicine.

Rochester Roentgen-ray Society.—Chairman, Joseph H. Green, M.D., 277 Alexander St.; *Secretary*, S. C. Davidson, M.D., 277 Alexander St. Meetings at convenience of committee.

Society of Radiological Economics of New York.—President, Albert L. Voltz, M.D., 115–120 Myrtle Ave., Richmond Hill; *Vice-president*, M. M. Pomeranz, M.D., 911 Park Ave., New York City; *Secretary*, W. F. Francis, M.D.; *Treasurer*, Theodore West, M.D., United Hospital, Port Chester. Meetings first Monday evening each month at McAlpin Hotel.

NORTH CAROLINA

Radiological Society of North Carolina.—President, Robert P. Noble, M.D., 127 W. Hargett St., Raleigh; *Vice-president*, A. L. Daughtridge, M.D., 144 Coast Line St., Rocky Mount; *Secretary-Treasurer*, Major I. Fleming, M.D., 404 Falls Road, Rocky Mount. Meetings with State meeting in May, and meeting in October.

OHIO

Cleveland Radiological Society.—President, North W. Shetter, M.D., Lakewood City Hospital, Lakewood; *Vice-president,* John Heberding, M.D., St. Elizabeth's Hospital, Youngstown; *Secretary-Treasurer,* Harry Hauser, M.D., Cleveland City Hospital, Cleveland. Meetings at 6:30 P.M. at Cleveland Chamber of Commerce Club on fourth Monday of each month from October to April, inclusive.

Radiological Society of the Academy of Medicine (Cincinnati Roentgenologists).—*President,* B. M. Warne, M.D., Doctors Building, Cincinnati; *Secretary-Treasurer,* Justin E. McCarthy, M.D., 707 Race St., Cincinnati, Ohio. Meetings held third Tuesday of each month.

PENNSYLVANIA

Pennsylvania Radiological Society.—President, Charles S. Caldwell, M.D., 520 S. Aiken, Ave., Pittsburgh; *First Vice-president,* Thomas L. Smyth, M.D., 111 N. 8th St., Allentown; *Second Vice-president,* Reuben G. Alley, M.D., Western Pennsylvania Hospital, Pittsburgh; *Secretary-Treasurer,* Lloyd E. Wurster, M.D., 416 Pine St., Williamsport; *President-elect,* Louis A. Milkman, M.D., 212 Medical Arts Bldg., Scranton; *Editor,* William E. Reiley, M.D., Clearfield. Annual meeting, May, 1939. Exact date and place to be decided.

Philadelphia Roentgen Ray Society.—President, Thomas P. Laughery, M.D., Germantown Hospital; *Vice-president,* Elwood E. Downs, M.D., Jeans Hospital, Fox Chase; *Secretary,* Barton H. Young, M.D., Temple University Hospital; *Treasurer,* R. Manges Smith, M.D., Jefferson Hospital. Meetings first Thursday of each month from October to May, Thompson Hall, College of Physicians, 19 S. 22nd St., 8:15 P.M.

The Pittsburgh Roentgen Society.—President, William B. Ray, M.D., 320 E. North Avenue, N. S. Pittsburgh; *Secretary,* Harold W. Jacox, M.D., 4800 Friendship Ave. Meetings held second Wednesday of each month at 4:30 P.M., from October to June at various hospitals designated by program committee.

RHODE ISLAND

See New England Roentgen Ray Society.

SOUTH CAROLINA

South Carolina X-ray Society.—President, Robert B. Taft, M.D., 105 Rutledge Ave., Charleston; *Secretary-Treasurer,* Hillyer Rudisill, M.D., Roper Hospital, Charleston. Meetings in Charleston on first Thursday in November, also at time and place of South Carolina State Medical Association.

SOUTH DAKOTA

Meets with Minnesota Radiological Society.

TENNESSEE

Memphis Roentgen Club.—Chairmanship rotates monthly in alphabetical order. Meetings second Tuesday of each month at University Center.

Tennessee State Radiological Society.—President, S. S. Marchbanks, M.D., 508 Medical Arts Bldg., Chattanooga; *Vice-president,* Steve W. Coley, M.D., Methodist Hospital, Memphis; *Secretary-Treasurer,* Franklin B. Bogart, M.D., 311 Medical Arts Bldg., Chattanooga. Meeting annually with State Medical Society in April.

TEXAS

Texas Radiological Society.—President, R. G. Giles, M.D., Medical Arts Bldg., San Antonio; *President-elect,* Jerome H. Smith, M.D., Shannon West Texas Memorial Hospital, San Angelo; *First Vice-president,* C. F. Crain, M.D., 416 Chaparral St., Corpus Christi; *Second Vice-president,* M. H. Glover, M.D., 904 8th St., Wichita Falls; *Secretary-Treasurer,* G. D. Carlson, M.D., 3121 Bryan St., Dallas. Meets annually. San Antonio is place of meeting, Oct. 22, 1938.

VERMONT

See New England Roentgen Ray Society.

VIRGINIA

Radiological Society of Virginia.—President, Fred M. Hodges, M.D., 100 W. Franklin St., Richmond; *Vice-president,* L. F. Magruder, M.D., Raleigh and College Aves., Norfolk; *Secretary,* V. W. Archer, M.D., University of Virginia Hospital, Charlottesville.

WASHINGTON

Washington State Radiological Society.—President, H. E. Nichols, M.D., Stimson Bldg., Seattle; *Secretary,* T. T. Dawson, M.D., Fourth and Pike Bldg., Seattle. Meetings fourth Monday of each month at College Club.

WISCONSIN

Milwaukee Roentgen Ray Society.—Secretary, S. A. Morton, M.D., Columbia Hospital, Milwaukee. Meets monthly on first Friday.

Radiological Section of the Wisconsin State Medical Society.—Secretary, Russel F. Wilson, M.D., Beloit Municipal Hospital, Beloit. Two-day annual meeting in May and one day in connection with annual meeting of State Medical Society, in September.

University of Wisconsin Radiological Conference.—Secretary, E. A. Pohle, M.D., 1300 University Ave., Madison, Wis. Meets every Thursday from 4 to 5 P.M., Room 301, Service Memorial Institute.

EDITORIAL

LEON J. MENVILLE, M.D., *Editor* HOWARD P. DOUB, M.D., *Associate Editor*

RADIOLOGY IN THE TEACHING OF PATHOLOGY[1]

A proper consideration of this subject depends upon one's conception of pathology, philosophy of teaching, and ideas of the proper position of specialties in human activities. Quite naturally there are, and will always be, differences of opinion relative to each of these divisions of our subject.

I hope you will be tolerant with me if I seem to speak my personal opinions very emphatically. You have asked for these and I shall give them despite the fact they may not meet with your approval. We must have extremes of opinion presented in order to establish a practical compromise.

May I state definitely that I believe the greatest advances in medicine have been made by radiology, particularly its subdivision known as roentgenology. This thesis I would be willing to defend before any audience in the world. I make this statement because I am apt to say some things about specialties which may seem very severe; if taken alone they may be interpreted as being unjustly critical. Specialization has certainly a place in human activity.

I shall present to you what I consider the ideal teaching of pathology, and relate it, if possible, to your particular specialty of radiology. Radiology, according to your own organization, has been defined as "that branch of medical science which deals with the use of radiant energy in the diagnosis and treatment of disease." Pathology, according to a certain standard medical dictionary, is "that branch of medicine which treats of the essential nature of disease, especially of the structural and functional changes caused by disease." This definition, unlike yours for radiology, is extremely narrow and incomplete. In my opinion, and in my practice, pathology is the science of disease, and as such pertains to all phases of disease with the exception of the actual mechanics of treatment, which, of course, it directs; it deals with the nature, diagnosis, prognosis, and treatment of disease; it is the whole field of medicine minus the actual care of the patient.

Teaching means, according to the dictionary, "the showing, guiding, making known, training, accustoming, the giving of lessons, instruction, imparting of knowledge, and the making aware of something by information or experience." In practice it has four functions: the presentation of known facts, the teaching of how to learn facts, the inspiration to learn facts, and the teaching of the application of facts to human welfare, progress, and happiness.

Your field of radiology and mine of pathology have been called specialties. They are too frequently considered, very narrowly and superficially, as something apart from the art of medicine. I have often heard the ridiculous remark by some physicians, speaking defensively and largely for their own emulation, that so-and-so is "just a pathologist." I have even heard, "Oh, he is just a radiologist," insinuating, of course, that being either pathologist or radiologist such an one could never know much about so-called clinical medicine. You and I have seen many clinicians who were merely specialists in distributing drugs for commercial manufacturers. In general, I think we may say truthfully that nothing so frequently blinds the specialist as specialization, and there is no stronger emotion than jealousy.

Now let me tell you how I think pathology should be taught, basing my thesis on the belief that pathology is the science of disease. I cannot conceive of a great professor of pathology who does not know something of all specialties in medicine and is not at the same time a very good clinician. One cannot teach disease only in the autopsy room, from pickled specimens, or with embedded and distorted tissues under a microscope; it cannot be taught from a test tube. The problem is one of knowing the facts about disease regardless of

[1] Read before the Seventh Annual Conference of the American College of Radiology, Chicago, Feb. 14, 1937.

what instruments are used to find them out; autopsy tables and knives, surgical knives, endoscopes, roentgenoscopes, microscopes, precision balances, burettes, flasks, hemacytometers, test tubes, cardiographic machines, ophthalmoscopes, laryngoscopes, and stethoscopes are all means of broadening observation and nothing more. They are only parts of the mechanics of seeing, feeling, hearing, smelling, or tasting. They are not valid reasons for developing independent fields of medicine.

Extension of observation, economy of time and energy, personal interest, and too frequently, rapid financial reward are the usual reasons for the development of specialties as we now know them; I am not so certain that such develop expertness in the art of medicine. Quite naturally one becomes more adept in one's special mechanical field; but the fallacy lies in the development of such expertness before there is a wholesome appreciation of the whole picture of disease. Specialists in medicine, as I have seen them, may be placed in two groups: technicians, and medical consultants, the latter being frequently quite adept in some particular method. Thus we find some specialists who are trained in the mechanical use of roentgenographic machines, radium applicators, endoscopes, stethoscopes, ophthalmoscopes, test tubes, balances, or microscopes, who know very little of the science of disease and its application in the art of medicine. Some of the most ignorant doctors I have seen are specialists; some of the wisest and best are general practitioners on the frontiers of the practice of medicine. It is the practitioner of medicine I have always in mind when I attempt to teach pathology; apparatus is of secondary consideration.

I believe that a professor of pathology should teach disease at the autopsy table, at the operating table, in the wards, in the dispensaries, and in the laboratories. If he leaves out any one of these he is giving the students a one-sided and too often misleading conception of disease—one that is not the picture doctors see, and need, in practice. The professor should be on excellent terms with all specialists in his institution or practice and should bring their findings together in visualizing the whole picture as it exists in the patient. There should be a professor of the practice of medicine and a professor of the principles of medicine and the latter should be the professor of pathology.

In carrying out this ideal with my graduate students, visiting doctors, and a small group of under-graduates I have the patient and all data present when I consider any disease. I personally see thousands of patients and their x-ray films with and without the aid of interpretative radiologists. I never make the roentgenograms; a good technician can do that. In fact, I always have one assistant who is a radiologist and who expects to follow that particular specialty; his mornings are spent in my laboratories and in operating rooms; his afternoons are spent with radiologists who interpret films and fluoroscopic findings. You will find one of our chief radiologists in my laboratories every day.

If our late friend and pioneer, Russell Carman, did something progressive for gastric diagnosis, prognosis, and treatment, it was due to the fact that he saw his patients roentgenographically one day, saw them operated upon the next day, and looked at what was removed as soon as it was removed. He and I spent many happy and very profitable mornings together trying to translate the macroscopic and microscopic characteristics of gastric and duodenal lesions into the findings we both saw in roentgenograms. He was a radiologist and I a pathologist. He made no claim to being an expert pathologist and certainly I made no claim to being a radiologist. We worked together, each contributing his part to the science of disease and learning to direct the mechanics of treatment. He was a pathologist using an x-ray machine and I a pathologist using a microscope. Both of us were doctors of medicine contributing to the science of disease and the practice of medicine. I presume we were also "just specialists."

If a professor of pathology is interested only in teaching postmortem morbid anatomy and mummified histology, his title is a misnomer. But if he is really teaching disease then he is an appreciator of, and an active participator in, every specialty that assists in diagnosis, prognosis, and treatment. His sole motto should be, "What can I contribute to the nature, diagnosis, prognosis, and treatment of disease; and how can I help to make every specialist in his particular field a better pathologist—a better contributor to the science of disease?" Personally I recognize no specialists excepting the pure technical experts. A member of our profession is either a doctor or a pure technician or neither one. Of course, he can be both technician and doctor, and I believe that is the

ideal of your organization. But first he should be a doctor.

When it comes to teaching pathology, roentgenology is merely one instrumental method of recognizing disease during life, and the use of therapeutic radiology is merely one method of treating disease during life. If we teach living pathology we must of necessity use the instruments of radiology and the technicians of radiology in seeing morbid anatomical conditions. Otherwise it cannot be well done.

May I close with some strong statements? The practical solution of the problem of cancer to-day is being retarded merely because both pathologists and practising physicians are not making greater use of roentgenology. We still have the startling fact that not over 25 per cent of our gastric cancers have been x-rayed before reaching our clinic. This is a sad commentary on that supreme specialty—the practice of the art of medicine. Seventy-five per cent of all cancers of the stomach are still hopeless. This can be avoided only by making radiologists better pathologists and pathologists and practitioners of medicine more familiar with the value of radiology in the study of the nature, diagnosis, prognosis, and treatment of disease. There is a great place for radiology in the teaching of pathology.

WILLIAM CARPENTER MACCARTY, M.D.

ANNOUNCEMENTS

THE NEXT ANNUAL MEETING

REFRESHER COURSES

The Refresher Series, post-graduate course, as announced in the July issue of RADIOLOGY, will occupy six hours on Sunday and two hours, from eight to ten, Monday morning the week of the Annual Meeting at Pittsburgh. The subjects chosen are considered basic and will be systematically presented by a faculty of nationally known teachers.

Enrollment cards will be enclosed in the Annual Letter mailed to the membership thirty days before the Annual Meeting. Space available at the hotel requires the limitation of these courses to sixty in each class. Enrollment of the members will be made as the applications are received. No admission fee will be charged.

It is hoped that the proposed series will justify a more comprehensive, perhaps longer, series next year. Applications for enrollment should be promptly returned on the self-addressed, stamped card included in the Annual Letter.

COMMITTEE ON
PUBLICITY AND EDUCATION

GENERAL ARRANGEMENTS

The members of the Radiological Society of North America are urged to attend the next Annual Meeting which is to be held in Pittsburgh, from November 28, 1938, to December 2, 1938.

The local committees are co-operating with the Society's standing committees, planning in every possible way to make this an outstanding meeting.

The institution of the Refresher Courses for Sunday and Monday sounds very interesting. Attendance upon these courses will keep the roentgenologists in touch with new ideas and new methods.

The Pittsburgh Roentgen Society is planning to provide opportunities for members who are interested, to visit some of the large industries. These will be listed, and registration will be necessary. Transportation will be provided.

ZOE A. JOHNSTON, M.D.
Chairman, GENERAL ARRANGEMENTS
COMMITTEE

RAILWAY SURGEONS TO MEET IN CHICAGO

Never before in the history of the Railway Surgeons have problems been so grave economically, or technic and treatment procedures of such import as exist this year.

The twenty-third annual meeting of the American Association of Railway Surgeons will be held at the Palmer House, Chicago, Sept. 19 to 23, 1938.

This association includes members in practically every railroad company in the United States, as well as the separate group organizations, embracing railroad surgeons of the New York Central System; Southern Railway; Atlantic & West Point R.R.; Western Ry. of Alabama; Illinois Central System; Chicago, Milwaukee, St. Paul & Pacific R.R.; Rock Island Lines; Chicago, Burlington & Quincy R.R.; Chicago and Northwestern R.R.; the Georgia Railway and other road associations.

An extremely interesting and highly profitable program has been arranged and all physicians and surgeons are invited to attend the

sessions of this meeting as guests of the organization. There will be no registration fee to physician non-member guests.

In addition to the scientific exhibits, a technical show will be held, including the presentation of new equipment, advanced types of therapy, new pharmaceutical and biological products, and the latest technics in many branches of the profession.

A cordial invitation for you to attend is extended by Dr. Harvey Bartle, President of the Association. Complete program and information regarding the meeting and the exhibits may be secured by addressing Mr. A. G. Park, Convention Manager, the American Association of Railway Surgeons, Palmer House, Chicago, Illinois.

COMMUNICATIONS

INTER-SOCIETY COMMITTEE FOR RADIOLOGY

Recent developments indicate that a solution to the problems arising from hospital-radiologist relations may be rapidly forthcoming, thus putting an end to an unfortunate controversy which has existed for a number of years between organized medicine and the organized hospital world. The advent of hospital care insurance and the determination on the part of a few hospital boards to bolster decreasing endowment income with profits from medical services performed in the hospital has brought the question to a head within the last few years.

Both sides of the controversy have taken a definite stand for perhaps the first time and now, with the question clearly defined, there is greater opportunity for positive solution. In a series of resolutions adopted at the San Francisco session in June, the American Medical Association quite definitely voiced its attitude that the practice of medicine, in all its branches, belonged to physicians and that the tendency of some hospitals to exploit specialists in radiology, pathology, and anesthesia should be deplored. When the House of Delegates threatened hospitals that exploited the profession or the public with removal from the approved list of the Council on Medical Education and Hospitals, the American Hospital Association made known its attitude in a published statement of principle published in its July *Journal.*

Thus the issues are clearly drawn and opposing forces are lined up for a final decision that will, among other things, solve the question of relations between hospitals and radiologists. The American Medical Association states that, "It is unethical and therefore contrary to good public policy for hospitals to participate in the practice of medicine in order to obtain an income to finance other hospital activities or to attempt to lower the cost of special medical services by methods that impair the quality of the service or prevent the development of an improved service."

Other statements in the report of the Board of Trustees which were approved by the House of Delegates declare that, "To-day action must be directed against the attempt of corporations and associations to practise medicine by employing nurses and technicians under the tacit supervision of salaried physicians. . . . To offer a lower cost service, hospital administrators and even some physicians have delegated many anesthesia, radiologic, and pathologic duties to nurses and technicians. . . . The opportunities for physicians to establish desirable practices in these fields are becoming so limited that they turn to other types of practice. . . . The proper method of remuneration for the hospital and the physician should enable the hospital to provide adequate building, equipment, and personnel without necessitating an attempt to control or to employ physicians."

Following the publication of this report the Board of Trustees of the American Hospital Association called a meeting and lost no time in making it known that they represented an entirely different point of view. In a set of principles adopted on June 18, they declared that, "The primary obligation of the hospital is to provide all the services necessary for the diagnosis, treatment, and rehabilitation of the patient. . . . The performance of diagnostic and therapeutic procedures by staff members constitutes the practice of medicine *in* hospitals. It is not the practice of medicine *by* hospitals."

The question: Shall medicine be practised by private self-employed physicians on a fee-for-service basis, or shall it be practised by employees of a hospital corporation that shall dictate the income to be derived by the practitioner from his profession?

The American Medical Association clearly recognizes that if hospitals are permitted to take over the practice of radiology, pathology, *et cetera*, they are likely to take over other

specialties as hospital practice increases. Said the report of the Board of Trustees, "The present situation in the practice of anesthesia, pathology, and radiology in hospitals and the potentiality of increasing the number and variety of special medical services controlled by hospitals call for the establishment of [an] ideal standard designed to permit a constant improvement of practice in hospitals."

New complications arose when the Philadelphia County Medical Society, after a two-year battle to exclude radiologic services from the hospital benefits, offered in a proposed group insurance plan, sought an injunction to stop hospitals from proceeding with a plan which included certain medical services. Evidence is now being heard by a Master appointed by the Court who will submit his findings of fact to the Court. Representatives of organized hospitals have been asked to testify and it is understood that the Philadelphia County Society has been promised assistance from the American Medical Association.

In an editorial in its July issue, the *Journal of the American Hospital Association* deplores the action taken in Philadelphia. Under the title "We Take Our Stand," the *Journal* lamented that the positive stand may "compel hospitals generally to fight to maintain existing and necessary standards of organization and service."

Whatever the outcome, radiologists should be mindful and appreciative of the firm stand taken by the American Medical Association in support of principles long desired by radiologic organizations. The official pronouncements of the House of Delegates strongly support the contention of radiologists that, whatever method is used for reimbursing the hospital for its maintenance costs in the radiologic department, no substantial net profit from the professional services of the physician should go to the hospital.

Following consideration of resolutions introduced by Dr. E. H. Skinner, Dr. F. F. Borzell, and Dr. C. H. Goodrich at the San Francisco session, the Council on Medical Education and Hospitals submitted a report concerning the practice of medicine in hospitals by radiologists, pathologists, and anesthetists. Said the report: ". . . . .The Council believes that these problems are of vital concern to the medical profession; unwise decisions at this time may lead to consequences that would be disastrous to physicians and to the public alike, and that, therefore, a serious study should be made of existing relationships between hospitals and physicians practising therein, especially in the departments of anesthesia, radiology, pathology, and physical therapy, with a view to standardizing the relationship of these services to the hospital and, where necessary, of reaffirming the principles of ethics involved." The report was adopted by the House.

In a subsequent resolution the House of Delegates reiterated its disapproval of the inclusion of radiology, pathology, *et cetera*, in group hospitalization plans unless the benefits are specified as cash payments to the subscribers for the cost of these services. The House also adopted a report by the Judicial Council concerning renting of radium and stating that, " . . . .the prescribing and directing of its use in the case of a patient whom the prescriber has not examined or seen is an unethical medical procedure."

The Inter-Society Committee owes much to Dr. E. H. Skinner and Dr. F. F. Borzell for earnest attention to radiologic questions during the House sessions. The helpful and cooperative attitude of the headquarters staff of the parent medical body, the American Medical Association, is enabling radiologists to gradually work out sound solutions to the many problems arising in hospital practice.

MAC F. CAHAL
Executive Secretary
540 North Michigan Avenue
Chicago

REPORT ON CANCER OF THE LIP

To the Editor: Early in 1937 I wrote to the members of the American Radium Society, the American Roentgen Ray Society, and the Radiological Society of North America, asking for data bearing upon the relationship, if any, between smoking and lip cancers. Compilation of the returned cards gives the following results:

Number of cases of cancer of the lip, 750
Number of smokers, 573
Number of non-smokers, 177
Number who habitually held pipe, etc., on affected side, 241
Number who habitually held pipe, etc., on opposite side, 137
Number who held pipe, etc., on either side or do not know which side, 195

Respectfully,
ARTHUR W. ERSKINE, M.D.

A PIONEER IN ROENTGENOLOGY

Professor Herman Gocht, one of the foremost pioneers in roentgenology in Germany, died recently at the age of 70, in Berlin. He did his first work in the surgical-orthopedic clinic of Professor Hoffa, in Würzburg, the same university where roentgen rays were discovered. In 1898 he published the first text-book on roentgenology. The book appeared in its seventh edition in 1921. He also edited a yearly volume, indexing the more important publications dealing with all branches of radiology.

Professor Gocht was one of the charter members of the German Roentgen Society, founded in 1905, and served as president in 1908. An appropriate necrology has been written by H. Meyer in *Strahlentherapie*, issue of June 24, 1938.

ERNST A. POHLE, M.D., Ph.D.

A NEW RADIOLOGICAL CENTER AT SHREVEPORT, LOUISIANA

RADIOLOGY always welcomes the opportunity to announce a new institution for the treatment of malignant disease by radiation therapy. At present, there is being erected and equipped at Shreveport, La., under the management of S. C. Barrow, B.S., M.D., F.A.C.R., W. R. Harwell, M.D., both radiologists, and W. P. Butler, M.D., pathologist, an institution which is to be known as a Radiological Center. It is proposed to administer supervoltage therapy, deep therapy, and radium therapy, as indicated. There is also to be a diagnostic department, as well as equipment for the administration of electrocoagulation and ultra-violet light treatments, and to take basal metabolism readings.

Dr. Barrow is well known to members of the Radiological Society of North America, and his friends wish him a generous measure of success.

A NOTE OF EXPLANATION

The report of the Bureau of Medical Economics of the American Medical Association, published in the April 30 issue of the *Journal of the American Medical Association*, was erroneously referred to in last month's issue of RADIOLOGY as a report of the Inter-Society Committee for Radiology. The Committee called attention to the Bureau's report and distributed reprints of the splendid study with a note of commendation to the personnel of the Bureau, but our announcement referring to the report itself as emanating from the Inter-Society Committee was inaccurate. Apologies and repeated congratulations to Dr. R. G. Leland and his Bureau.

IN MEMORIAM

LESTER I. LEVYN, M.D.

Dr. Levyn was born in Buffalo, N. Y., on Dec. 28, 1884. He attended the University of Buffalo for two years, after which he completed his collegiate course at the University of Maryland, from which he was graduated in 1909. He did post-graduate work in Berlin, at London University, in Vienna, and at Harvard Medical School. Returning to Buffalo, he maintained offices and laboratories and was also a member of the Deaconess Hospital staff.

The late LESTER I. LEVYN, M.D.

A radiologist of international fame, Dr. Levyn held membership in the Radiological Society of North America, the American Roentgen Ray Society, all his local, county, state, and national medical societies, and was, besides, a diplomate of the American Board of Radiology. He read and published numerous papers on radiological subjects.

Dr. Levyn's untimely death has been genuinely mourned by his many friends.

BOOKS RECEIVED

Books received are acknowledged under this heading, and such notice may be regarded as an acknowledgment of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

ULTRAKURZWELLEN IN IHREN MEDIZINISCH-BIOLOGISCHEN ANWENDUNGEN (Ultra-short Waves and Their Medico-biologic Applications). By H. DANZER, H. E. HOLLMANN, B. RAJEWSKY, H. SCHAEFER, and E. SCHLIEPHAKE. Volume I.—Ergebnisse der biophysikalischen Forschung (Contributions to Biophysical Research). Edited by Prof. Dr. B. Rajewsky. A volume of 308 pages, with 188 illustrations and 24 tables. Published by Georg Thieme, Leipzig, 1938. Price: R.M. 21.00, bound, less 25 per cent

RÖNTGENATLAS DER ASBESTOSE DER LUNGEN (Roentgen Atlas of Asbestosis of the Lung). By Prof. Dr. ERICH SAUPE, Roentgen and Radium Departments of Rudolf-Hess Hospital, Dresden. Editor: Prof. Grashey, Koln. Fortschritte auf dem Gebiete der Röntgenstrahlen (Progress in the Provinces of Roentgen Rays). A volume of 99 pages, with 52 illustrations. Published by Georg Thieme, Leipzig, 1938. Price: R.M. 19.50.

DER KREUZSCHMERZ IN SEINER BEZIEHUNG ZUR WIRBELSAULE (Back Pain and its Relation to the Vertebræ). By Priv.-Dozent Dr. J. E. W. BROCHER, together with a Preface by Prof. Dr. VOLHARD, Frankfort-on-Main. Supplementary Volume 55 of the *Fortschritte*, edited by Prof. Grashey, Koln. A volume of 89 pages, with 101 illustrations. Published by Georg Thieme, Leipzig, 1938. Price: R.M. 21.50, bound, less 25 per cent.

RÖNTGENATLAS DER LUNGENERKRANKUNGEN (Roentgen Atlas of Lung Diseases). An introduction for physicians by Dr. W. BREDNOW, a.o. Professor of internal medicine and roentgenology, Chief Physician of the Univ. Klinik in Gottingen, and Dr. E. HOFMANN, Roentgenologist, Chief Physician of the Roentgen Division of the City. Third, completely new, revised and enlarged edition. A volume of 248 pages, with 127 illustrations. Published by Urban & Schwarzenberg, Berlin, 1938. Price: R.M. 13.50.

BOOK REVIEWS

POLSKI PRZEGLAD RADIOLOGICSNY (Polish Review of Radiology). Journal of the Polish Society of Medical Radiology and Physiotherapy. Volume 12, Numbers 2 and 3. Edited by Dr. W. Zawadowski, Warsaw, Poland. Published in 1937. Price not stated.

This volume contains a number of interesting papers by well-known radiologists in Europe. The papers are published in Polish but there is a summary of each in French. The text contains the following original papers:

A. Schüller, "The Late Results of Trauma of the Skull Revealed by X-ray Examination."

S. Spett, "Tumors of the Cerebellopontine Angle."

Z. Krupinski, "Unusual Lengths of the Styloid Process of the Temporal Bone."

K. Korolkiewicz, "Fractures of the Cervical Spine."

K. Dering-Ossowska, "Two Cases of Trauma of the Spine in Children."

M. Werkenthin, "Pulmonary Atelectasis."

F. Fleischner, "Atelectasis in Pulmonary Tuberculosis."

K. Dering-Ossowska, "Pulmonary Atelectasis in Infants."

M. Goldman, "Cystic Disease of the Lung."

M. Jakubowicz, "Respiratory Displacement of the Thoracic Aorta."

S. Calka, "A Case of Hemangioma of the Soft Tissues of the Forearm."

J. Zorawska, "The Adaptation of a Back Rest Permitting the Taking of Radiographs in Bed."

S. Januskiewicz, "The Organization of Records in a Diagnostic Radiological Service."

In addition to the original papers, the volume contains transcripts of the various meetings of the Polish Society, reports of the International Congress in Chicago, and reviews from the literature.

LA HERNIE POSTERIEURE DU MENISQUE INTERVERTEBRAL ET SES COMPLICATIONS NERVEUSES (Posterior Herniation of the Intervertebral Disk and its Neurologic Complications). By PIERRE GLORIEUX, Bruges. A volume of 102 pages, with 98 illustrations. Published by Masson et Cie, Paris, 1937. Price: 40 fr.

This is a comprehensive presentation and analysis of the author's observations in 25 cases of posterior protrusion of one or more intervertebral disks. The data concerning 13 cases are presented in great detail, together with reproductions of related x-ray films. The

surgical findings are given in four instances and the necropsy findings in one. The text is composed of four parts: The first is of a general nature and concerns the etiology, pathologic anatomy, and statistics relating to the condition; Part 2 is a report in detail of 13 illustrative cases; Part 3 is a comprehensive discussion of (*a*) the radiological signs and (*b*) the differential diagnosis; Part 4 concerns the prognosis, medico-legal aspects, and treatment.

It is interesting indeed that the author, in spite of his rather limited experience with this condition, has been able to write such a comprehensive and informative monograph concerning this subject which is of considerable current interest. Great importance is attached to the roentgenologic lipiodol examination, and the significant changes are described in great detail. This part is amplified by numerous drawings which show very clearly the basic reasons for the type of filling defect observed in various positions.

No mention is made of the part that hypertrophy of the ligamentum flavum, which so frequently accompanies a protruded disk, plays in the lipiodol defect and the consequent diagnosis. However, in spite of this deficiency in the text, this monograph is an excellent presentation of an important subject of current interest, and will prove very useful to roentgenologists who can read French.

A Manual of Radiological Diagnosis. For Students and General Practitioners. By Ivan C. C. Tchaperoff, M.A., M.D., D.M.R.E. (Camb.), Assistant Radiologist and Radium Registrar, St. Thomas' Hospital, London, with a Foreword by Philip H. Mitchiner, M.D., M.S., F.R.C.S., Surgeon to St. Thomas' Hospital. A volume of 256 pages, with 286 illustrations. Price: $6.00.

In this volume of 256 pages the author has endeavored to present a synopsis of the essentials of x-ray diagnosis for students and general practitioners. The text consists of eight chapters devoted to the following subjects: x-ray physics and technical considerations, bones and joints, chest and heart, alimentary tract, gall bladder, female generative system and fetus, and tumors of the spinal cord, and ventriculography.

Those for whom the book is intended will probably feel that it is a very good presentation of the subject. However, the roentgenologist will feel that the text, in general, is too abbreviated and many phases are treated so inadequately that a fair appraisal of the usefulness of the x-ray examination in many conditions is impossible. In the chapter concerning the gall bladder the procedure given for cholecystography is quite different from that generally used in this country and in many foreign clinics. The author's statement that failure of the gall bladder to fill is no indication of a diseased gall bladder is difficult to reconcile with the accepted fundamental purpose of the examination. The discussion concerning tumors of the spinal cord is so brief and the method of examination given is so antiquated that this section could better be eliminated.

The text appears to be printed by the lithoprinting process or some similar method and the illustrations are above average quality, many being excellent indeed. The value of the text for students would be greatly enhanced by a bibliography of significant textbooks and articles.

The Construction of Vulcanite Applicators for Applying Radium to Lesions of the Buccal Cavity, Lips, Orbit, and Antrum. By Desmond Greer Walker, M.A., M. Dent. Sc., M.B., B.Ch., Assistant Dental Surgeon to the Royal Dental Hospital, Dental Registrar at the Middlesex Hospital, Chief Assistant to the Plastic Department, St. Bartholomew's Hospital. A volume of 61 pages, with 23 plates. Published for the Middlesex Hospital Press by John Murray, Albemarle Street, London, 1938. Price: 5 shillings net.

Tumors of the buccal cavity, antrum, and orbit are being treated with radium in increasing numbers with increasingly good results as the technic has improved year by year. This radiological work has been pursued in England with much enthusiasm and worthwhile effort. This little book is therefore timely. The subject matter is well covered by the title and deals with the mechanics of the construction of the intricate applicators arranged to hold radium needles or tubes in difficult locations, especially in the buccal cavity where delicate soft tissues have to be well protected and position is difficult to maintain. The formulæ of its preparations are given, including the popular Columbia paste, and a description of the modelling of the impression. The subsequent casting, as well as the use of lead protection, is carefully de-

scribed. The lead protection is embodied in the applicator itself and dummy radium needles and tubes are employed for exact approximation. Methods of suspension and fixation of the moulded applicators for long treatments are well explained. Of course, there is no discussion of dosage. This book is not written by a radiologist but a dental surgeon. The basic principles of protection are well explained and the book shows the value of co-operation of the radiologist and dentist in the difficult treatment of these lesions.

Probably the most noteworthy feature of this monograph is the excellent photographs which well illustrate the points brought out in the text. Of course, the technic of radium treatment of the areas under discussion is mainly a matter of actual practice, but this monograph is valuable in outlining the general principles of the work.

ABSTRACTS OF CURRENT LITERATURE

CONTENTS BY SUBJECT

THE FOLLOWING ABSTRACTORS HAVE CONTRIBUTED TO THIS ISSUE

S. M. Atkins, M.D., of Waterbury, Conn.
S. R. Beatty, M.D., of Madison, Wis.
G. E. Burch, M.D., of New Orleans, La.
J. A. Habbe, M.D., of Milwaukee, Wis.
Lewis G. Jacobs, M.D., of Madison, Wis.
H. A. Jarre, M.D., of Detroit, Mich.
E. T. Leddy, M.D., of Rochester, Minn.
John M. Miles, M.D., of Lafayette, La.
Davis H. Pardoll, M.D., of Chicago, Ill.
L. W. Paul, M.D., of Kansas City, Mo.
Ernst A. Pohle, M.D., Ph.D., of Madison, Wis.
W. A. Sodeman, M.D., of New Orleans, La.
Charles G. Sutherland, M.D., of Rochester, Minn.

ABSTRACTS IN THIS ISSUE LISTED ALPHABETICALLY BY AUTHORS

APPARATUS

Method of Radiologic Examination of Single Planes of the Body: Methods and Discussions. P. Ponthus. Jour. de méd. de Lyon, **19,** 15–21, Jan. 5, 1938.

Classical radiography is deficient in two respects. There is the possibility of a pathologic shadow being hidden by an overlying shadow of inverse density and there is no effect of relief. Radiography of selected planes overcomes some of the faults of ordinary radiography, but a number of the methods advanced lack precision and require the taking of films of several planes. Several of these methods are discussed (stratigraphy, planigraphy, and tomography). In order to avoid the necessity of taking a number of films and to make a preliminary selection of the plane to be radiographed, several other methods have been advanced, including the radiotome, wherein a combination of stereoradiography and geometrical construction is used, and stratiscopy, or fluoroscopy of a selected plane. There is special consideration of the apparatus for stratiscopy which is believed to be entirely practical in its present state of development. These methods are valuable because of their simplicity, rapidity, and precision for one part, and because of the importance of the additional information that they make available.

S. R. Beatty, M.D.

Pulmonary Stratigraphy. G. Ronneaux. Bull. et mém. Soc. de Radiol. Méd. de France, **25,** 786–793, December, 1937.

Planigraphy by the method of Vallebona, modified so that both the patient and the film are rotated while the tube is fixed, has been very successful in the author's experience. While complete exploration requires films taken of levels 2 cm. apart, it is usually possible, by preliminary selection, to reduce this number to five, three, or even one film. Not only is it possible, in many cases, to gain additional information concerning lesions visible on standard films but it is also possible to demonstrate clearly lesions not visible or masked on films taken in the usual manner. Several illustrative cases demonstrating delineation of hidden lesions of the lung are shown.

S. R. Beatty, M.D.

Dark-room Illumination. A. van Kreveld and J. A. M. van Liempt. Physica, **5,** 345–373, May, 1938 (in English). (Reprinted by permission from Science Abstracts, Sect. A, Physics, **41,** June 25, 1938.)

A study has been made of the requirements that dark-room lamps, used in the developing of negatives, have to satisfy in point of quality. Firstly, the sensitivity of the eye to contrasts under dark-room conditions was determined for the different colors from green to dark red. Secondly, the sensitivity of different photographic emulsions has been measured through the whole visible spectrum. From these measurements the optimum light for orthochromatic and panchromatic emulsions has been computed. Further, the energy of dark-room lamp causing an inadmissible decrease in photographic contrast, and from this the "quality" of an arbitrary dark-room lamp, has been calculated.

Authors.

Standardization Committee of the German Roentgen Society. Strahlentherapie, **62,** 128, 1938.

This is a publication of the rules and regulations regarding standardization and calibration of x-ray therapy equipment as proposed by the Standardization Committee of the German Roentgen Society.

Ernst A. Pohle, M.D., Ph.D

ARTERIOGRAPHY

Cerebral Arteriography. Hugh Davies. British Jour. Radiol., **10,** 871–881, December, 1937.

Davies reviewed the subject of cerebral arteriography, or cerebral angiography. The carotid artery is exposed under local anesthesia on the side or sides of the brain to be visualized, and from 10 to 12 c.c. of thorium dioxide (thorotrast) is injected; 15 to 17 c.c. is injected if the venous vessels as well are to be visualized. This is injected in 5 sec. and the radiograph is made just as the syringe is emptied. The exposure is short (0.1 sec.) and for this reason a Potter-Bucky diaphragm is advisable. With the use of a series of 12 × 10 in. cassettes passing in rapid succession below the patient's head, one can obtain a group of six films, taken at one-second intervals, showing various portions of the vascular tree, including the venous alterations of the normal vascular roentgenogram. These are used to diagnose and locate neoplasms, aneurysms, and other intracranial tumors.

George E. Burch, M.D.

ARTHRITIS

Gonococcic Arthritis: Pathogenesis, Mechanism of Recovery, and Treatment. Chester S. Keefer and Wesley W. Spink. Jour. Am. Med. Assn., **109,** 1448–1453, Oct. 30, 1937.

The diagnosis of gonococcic arthritis was made on the following grounds: (1) a history of a recent attack of gonorrhea; (2) evidence of a localized gonococcic infection of the genital tract; (3) a positive reaction to the gonococcus complement fixation test on the blood and/or synovial fluid, and (4) the demonstration of gonococci in the synovial fluid.

An acute polyarthritis appears subsequent to a gonococcic infection of the urethra or uterine cervix, less frequently of the conjunctiva or rectum. It is often abrupt in onset and is accompanied by all the signs of an intense inflammation involving periarticular tissues and synovial membrane. The process is more often

polyarticular. The joints most frequently involved are the knees, ankles, and wrists; any joint of the body may be affected. There is often intense tenosynovitis about the wrists and ankles and in some instances the tendon sheaths are involved without any conclusive sign of associated arthritis. Tenosynovitis is much more common in patients with gonococcic arthritis than in patients with other types of arthritis and is a valuable diagnostic sign. In most cases the arthritis begins within ten to twenty days after the onset of gonorrhea; it may occur months or years after an attack, even after the original infection of the genito-urinary tract has entirely healed.

The process is most intense within the first few days of onset and does not tend to be migratory unless there is trauma to the local focus of infection in the genito-urinary tract. Frequently, after the acute onset the process becomes more conspicuous in one or more joints where the features of the infection are most intense. The symptoms of the acute process persist for an indeterminate period; many persons are disabled for several weeks or months. Accompanying the acute process in the joints and tendon sheaths there is rapid wasting of the muscles supporting the affected joints. Histologic examination of muscle in the immediate neighborhood of the joints has failed to reveal evidence of acute inflammation.

Associated lesions, such as tenosynovitis, bilateral metastatic catarrhal conjunctivitis, iridocyclitis and keratodermia blenorrhagicum, are helpful clinical aids in the diagnosis.

The pathologic lesions in the joints begin in the periarticular tissues and synovial membrane, and involvement of the cartilage is secondary. Destruction of the cartilage is most conspicuous in the wrist, hip, and finger joints. Bony ankylosis is rare except in the wrist joints. Fibrous ankylosis is more common.

CHARLES G. SUTHERLAND, M.D.

BACKACHE

Pain Low in the Back and "Sciatica" Due to Lesions of the Intervertebral Disks. J. S. Barr, A. O. Hampton, and W. J. Mixter. Jour. Am. Med. Assn., **109**, 1265–1270, Oct. 16, 1937.

The rôle of the intervertebral disks in causing intractable "sciatic" radiation of pain from pressure of herniated disk tissue on one or more roots of the cauda equina in the lower lumbar region should be considered in the study of every case of strain low in the back and "sciatica."

Goldthwaite first suggested in 1911 that injuries to intervertebral disks might be a frequent cause of "lumbago" and "sciatica."

The patient is usually a healthy, vigorous man between the ages of 20 and 50 whose chief complaint is pain radiating unilaterally down the posterior part of the thigh and the posterolateral part of the calf. There may be pain in the buttock or in the lumbosacral or sacro-iliac region. There may be a sensation of numbness or tingling in the involved extremity. Bilateral radiation of pain, muscular weakness or paralysis, and incontinence of urine and feces are occasionally found and indicate severe damage to the cauda equina. A history of trauma to the lower part of the back was obtained in 80 per cent of their cases. The most common cause of trauma was sustained when the patient was lifting a heavy weight and felt something "give way" in the lower part of the back. In about half the cases trauma immediately preceded the onset of symptoms. About half of their patients had a history of remissions and exacerbations of their symptoms. Practically without exception they had had prolonged conservative orthopedic treatment consisting of rest in bed, support of the back, and exercises.

On physical examination, limitation of motion of the lumbar part of the spine by muscle spasm was the most characteristic observation. The usual lumbar lordosis was diminished or obliterated. Kyphosis may be present to such an extent as to simulate vertebral collapse. A fixed list ("sciatic scoliosis") of the lumbar part of the spine, which occurred toward or away from the affected side with about equal frequency, was commonly noted. Straight leg raising was limited almost always unilaterally and sometimes bilaterally. There was local tenderness over the lumbar spinous processes and interspinous ligament at the site of the lesion in many of the cases. There might be tenderness over the buttock, the sacro-iliac ligaments, and the course of the sciatic nerve. In most cases certain positions relieved and others aggravated the radiating pain.

Neurologic changes, motor, sensory, and reflex, may be totally absent in perhaps half of the cases. The most common neurologic finding was absence or diminishing of the ankle jerk on the affected side.

Roentgenoscopic examination after the injection of iodized oil is the most important step in the diagnosis. The lesion can be accurately localized and readily demonstrated on the roentgenogram.

No permanent ill effects were observed which could be attributed to the use of iodized oil in the spinal subarachnoid spaces.

The technic and the interpretation of the x-ray findings were described in detail.

Almost every patient was immediately relieved of pain in the leg after the operative removal of the ruptured disk.

CHARLES G. SUTHERLAND, M D.

Relation of the Fascia Lata to Conditions in the Lower Part of the Back. Frank R. Ober. Jour. Am. Med. Assn., **109**, 554–558, Aug. 21, 1937.

Any patient who complains of lame back should have a thorough general examination, including neurologic tests and adequate roentgenograms of the back. This means anteroposterior, stereo, lateral, and oblique views of the affected regions. In cases of bilateral sciatic pain and in cases of diminished or increased reflexes, a lumbar puncture should be considered to rule

out intraspinal lesions. If the fluid shows increased protein, a test with iodized oil may be necessary. Examination of the rectum should not be overlooked.

The physical examination includes the abduction test which the author describes in detail. In cases of backache in which the x-ray examination reveals nothing significant and there is abduction contracture, usually associated with Ely's sign, and limitation of straight leg-raising, some method of therapy should be instituted to overcome this condition.

The author presents the findings in 415 cases of fasciotomy on patients with lame back and sciatic pain: 21 per cent obtained no relief; 4 per cent had partial relief, and 75 per cent had complete relief. The average time before relief took place was three months.

CHARLES G. SUTHERLAND, M.D.

BILIARY TRACT

The Pathologic Physiology of the Common Bile Duct: Its Relation to Biliary Colic. Waltman Walters, John M. McGowan, Winfield L. Butsch, and Paul A. Knepper. Jour. Am. Med. Assn., **109,** 1591–1596, Nov. 13, 1937.

The first description of the sphincteric mechanism at the lower end of the common bile duct was apparently that of Gage (1879) but Vesalius (1543) was credited with calling attention to the membranes that prevent regurgitation of duodenal content (into the common bile duct), to the tortuousness of the entrance of the duct into the intestine, and to some impeding flow from the orifice (of the common bile duct). Oddi was the first to measure the resistance of the sphincter, "a more or less pronounced bed of circular fibers encircling the choledochal canal," which he demonstrated. He was the first to show that removal of the gall bladder caused a marked dilatation of the bile ducts and to postulate that dysfunction of the sphincter might explain certain morbid affections of the biliary tract—a prophecy which has recently become strikingly realized in the condition known as "biliary dyskinesia."

Studies of the pathologic physiology of the biliary tract associated with surgical lesions were made by visualizing the common and hepatic ducts under the fluoroscope and by roentgenographic studies after injection into the common duct through a T-tube of nonirritating substances which were opaque to the x-ray. The choledochograms so obtained revealed the presence of (1) any narrowing of the common bile duct and persisting pancreatitis, with an abnormally patent duct of Wirsung, (2) an overlooked stone in the common bile duct, (3) spasm or stenosis of the sphincter of Oddi, and (4) carcinoma of the ampulla of Vater or of the head of the pancreas.

Studies of the pressure within the common duct were carried out in a series of cases in which the common duct had been explored and drained by a T-tube. With spontaneous attacks of pain similar to that described as biliary colic, increase in intraductal pressure occurred. In some cases injection of morphine produced similar effects, and, when roentgenographic studies were made, spasm of the lower end of the common duct was noted and marked filling of the intrahepatic ducts with the opaque substance—used to measure intraductal pressure—was visualized. The action of various drugs on the common duct was studied, roentgenograms being used to visualize the appearance of the biliary tract and its ability to empty itself. Morphine, codeine, and dilaudid produced a marked increase in the pressure within the common bile duct because they produced a spasm in the sphincter at the lower end of the duct. Amyl nitrite, glyceryl trinitrate, and theophylline with ethylenediamine completely relaxed the sphincteric spasm and thus produced a fall in pressure.

CHARLES G. SUTHERLAND, M.D.

BONES, GROWTH

Local Overgrowth. Fremont A. Chandler. Jour. Am. Med. Assn., **109,** 1411–1414, Oct. 30, 1937.

Defective growth due to (1) deficiency of germ plasm, (2) circulatory failures occurring early in embryonic life, or (3) epiphyseal disturbances resulting from some obscure endocrine failure, disease, trauma or dyscrasia is encountered in the everyday practice of orthopedic surgery. In bilateral manifestation of arrested growth, experiment in fields of medicine is still somewhat nebulous, *e.g.*, endocrinology and vitamin therapy. Surgical procedures are rarely advocated for the relief of bilateral symmetrical arrest of growth. In unilateral arrest of growth the success of leg lengthening has been demonstrated. Shortening of the well leg is successful beyond doubt. Epiphyseal arrest of the longer extremity by surgical measures is most effective, and less hazardous, and is gaining rapidly in its field of usefulness.

The counterpart of arrested growth is overgrowth. Overgrowth may follow trauma to growing bone. Infections of the shaft of growing bone stimulate growth at the epiphysis, provided the function of these centers of growth is not impaired. Infections of joints, if not widely destructive, stimulate epiphyses to greater activity, first, in the lengthening of the diaphysis and, second, by increased osteogenesis in the subchondral area of the epiphysis itself. Low grade rheumatoid arthritis of the wrist of a small child will result in ossification of the carpal bones more advanced than that of the uninvolved member. The patella responds in a similar manner. This epiphyseal response may occasionally be seen in tuberculous joints. It is absent, of course, in the case of virulent destructive lesions of joints.

Bone grows in response to elements of traction or compression; the contour and architecture of osseous bodies reflect to a great degree external forces. The angle formed by the shaft and the neck of the femur is a composite of growth reaction in response to the tension and traction of the hip muscles and the compression force of weight-bearing occurring throughout the normal

arcs of function. Should the arc of function be restricted, alteration in the angle of the femoral neck may be anticipated.

Injury to the germ plasma of an early embryo may result in a great variety of congenital deformities and the incidence of deformities in succeeding generations remains high.

The association of local overgrowth of tissue with maldevelopment of the vascular system has been emphasized by many writers. Alterations in the rate of growth may be due to the increased circulation of intercellular fluid or possibly to the increased temperatures which are found. Intercommunications between the larger vessels (arteriovenous fistulas) result in a distinct elevation of the oxygen tension of the blood, especially in the venous system. All portions of the extremity involved develop at an accelerated rate of growth. This rate continues until growth ceases or compensatory mechanisms fail and gangrene supervenes. Lymphatic obstruction by parasites may also cause overgrowth of the involved extremity, provided of course that infection occurs in the period of growth.

CHARLES G. SUTHERLAND, M.D.

THE BRAIN

The Early Diagnosis of Intracranial Tumor. Norman M. Dott. British Med. Jour., pp. 891–895, Nov. 6, 1937.

Dott has used ventriculography in about 40 per cent of brain tumor cases. In 60 per cent the diagnosis seemed accurate enough for operative purposes without it. The percentage of cases given this diagnostic aid is increasing, particularly because operations have become more radical in character and require more exact diagnostic guidance. Similar results are obtained with cerebral vascular radiography with radiopaque medium. Arterial displacements around a tumor may yield fuller and more intimate information of its exact extent and relations. The ventricular picture tends to give wider information of anatomical conditions within the head and less detail of the tumor itself. Study of the veins may provide very valuable evidence. Many tumors are surrounded by a plexus or capsule of venous channels, and the actual outline of one of these vascular tumors may thus be seen. Further, the vascular architecture in and around certain tumors may be sufficiently characteristic to justify an opinion as to the actual pathology of the tumor. In cases of suspected aneurysm of the cerebral arteries, he has found the arterial radiograph of great value.

W. A. SODEMAN, M.D.

BREAST CANCER

Roentgen Therapy of Breast Cancer. W. G. McDeed, C. P. Harris, and E. M. Parker. Texas St. Jour. Med., **33,** 641–644, January, 1938.

The authors discuss the fundamental principles underlying radiation therapy of breast carcinoma and its complications. The Coutard technic is stressed. In their own practise they use a 200-kilovolt constant potential machine at 16 milliamperes with a Thoraeus filter equivalent to 2 mm. copper, giving an effective wave length of 0.11 Ångstrom. Two hundred r, measured in air, is applied every 48 hours to one of three skin areas until 2,800–3,000 r has been given to all skin surfaces. One posterior and two anterior portals are used. The resulting exfoliation is protected by sterile vaseline dressings and heals in from two to three weeks.

Metastases are treated for alleviating pain and retarding growth of the tumor cells. Moderate doses usually give quick relief of pain in spinal and pelvic metastases. Heavy doses, applied skillfully, in the majority of cases, cause replacement of the lesion with new bone. Patients below the menopause age who have osseous metastases should be castrated with x-ray. Further efficiency in the treatment of differentiated cancer may come from determining exactly the time of maximum sensitivity of the tumor cells.

JOHN M. MILES, M.D.

THE CHEST

The Roentgenological Chest Volume for Estimating Vital Capacity. Andrew L. Banyai. Am. Jour. Roentgenol. and Rad. Ther., **37,** 494–497, April, 1937.

Roentgenological chest volume is an accurate and practical means for estimating vital capacity and is superior to other methods based on body measurements. Determining roentgenological chest volume by the formula of Hurtado and Fray, the writer compared the ratio of roentgenological chest volume at maximal expiration to the roentgenological chest volume at maximal inspiration × 100, in 40 control cases and in 40 silicotics or silico-tuberculous patients. In the controls the figures obtained were less than 79 in all but one, while in the cases of silicosis and silico-tuberculosis, the ratio was 70 or more in 24, or 60 per cent, and less than 70 in 16, or 40 per cent. The author, therefore, concludes that a "volume ratio" of 70 or more constitutes an index suggestive of diminished vital capacity in patients with chronic pulmonary disease.

J. E. HABBE, M.D.

THE CRANIUM

Difficulties in the Radiologic Diagnosis in a Case of Cerebral Tumor. M. Raynaud, H. Tillier, F.-G. Marill, and R. D'Eshougues. Bull. et mém. Soc. de Radiol. Méd. de France, **25,** 718–721, November, 1937.

A case is discussed in which an opacity of the sphenoidal wing and destruction of the sella introduced the question of meningioma and sellar tumor into the differential diagnosis. The location of a displaced pineal calcification afforded a clue, sustained by encephalography, to a midline, subtentorial tumor.

S. R. BEATTY, M.D.

Encephalography by the Method of Laruelle in a Case of Cerebral Traumatism. J. Jalet. Bull. et mém. Soc. de Radiol. Méd. de France, **25,** 726, 727, November, 1937.

Findings suggestive of hematoma or cyst were made, in the case of a man who had sustained a severe blow on the head, after lumbar injection of air and roentgenographic visualization of the ventricles.

S. R. BEATTY, M.D.

DOSAGE

The Determination of the Effective Dose. L. Fiedler. Strahlentherapie, **62,** 119, 1938.

The Determination of the Effective Dose. (Discussion of the Article by Fiedler.) H. Holthusen. Strahlentherapie, **62,** 124, 1938.

The author makes a plea for the use of the dose in air in x-ray therapy in preference to the surface dose which includes back-scattering. The latter is difficult to measure, cannot be calculated very accurately, and the use of both terms side by side apparently leads to confusion.

Holthusen in his comment agrees with Fiedler partially but also points out the importance of the surface dose, whose determination should not be omitted.

ERNST A. POHLE, M.D., Ph.D.

The Protraction of the Roentgen Dose. K. Nitzge and H. Iven. Strahlentherapie, **62,** 91, 1938.

The authors determined the roentgen injury curves for tobacco plants with the dose applied according to the protracted method. The intensity was varied from 0.1 to 32 r per second. Instead of recording the injury at only one time, the irradiated plants were observed on four different days and the respective data recorded. While the authors do not wish to transfer the results of their studies to human therapy they feel that similar experiments on other objects and animals will lead to a better understanding and knowledge of the method of application of roentgen rays.

ERNST A. POHLE, M.D., Ph.D.

The Wave Length Distribution of the Scattered Radiation in a Medium Traversed by a Beam of X- or Gamma Rays. Ruby Payne-Scott. British Jour. Radiol., **10,** 850–870, December, 1937.

In a study of wave length distribution of scattered radiation, Payne-Scott concluded the following: A study of the absorption coefficients indicates that the function expressing the ratio between the amount of scattered and primary energy absorbed in water as the primary wave length is varied will show a maximum value in the neighborhood of 140 X.U., and that the position of this maximum will depend on the atomic number of the scattering medium, moving toward shorter wave lengths for heavier substances.

Calculations of the amount and distribution of the energy absorbed from the once scattered radiation in water for the primary wave lengths, 17.1, 50, 200, and 400 X.U., show that: The beam-width at which the amount of scattered energy absorbed becomes practically stationary depends on the quality of the primary radiation, being greater the shorter its wave length.

Owing to the presence of scattering, the decrease in the total amount of energy truly absorbed with increasing depth is much less than it would be if only the primary radiation were concerned, and for the harder radiations the amount actually increases for a short distance below the surface.

Of the four wave lengths considered, the amount of scattered energy absorbed relative to the amount absorbed from the primary radiation is a maximum for the wave length 200 X.U., and is very small for the shorter wave lengths.

Increasing beyond 5 cm., the thickness of the medium below a point makes practically no difference in the amount of scattered energy absorbed there.

A comparison between the theoretical and experimental values indicates that the amount of scattered radiation experimentally observed possibly includes a considerable proportion of radiation due to scatterings of the second and higher orders.

The curves giving the distribution of the absorbed energy over the wave length range of the scattered spectrum show that very little energy is contained in the long wave length region of the spectrum of the absorbed energy, most of the scattered energy absorbed differing very little from the primary radiation in wave lengths. This is particularly marked in the case of the shorter wave lengths, and will tend to minimize any effect due to a difference in quality between the primary and scattered radiations, especially when the primary radiation is of short wave length.

GEORGE E. BURCH, M.D.

FOREIGN BODIES

New Method of Localizing Foreign Bodies in the Body. P. Cottenot and B. Boudaghian. Bull. et mém. Soc. Radiol. Méd. de France, **25,** 797, 798, December, 1937.

The authors present a method of foreign body localization requiring two films taken as for stereoradiography. Employing the standard seriescope, it is possible to localize the foreign body, not only in relation to markers placed on the skin, but also in relation to the bony points, with an accuracy in the order of a millimeter.

S. R. BEATTY, M.D.

Frequency and Danger of Unrecognized Foreign Bodies of the Respiratory Passages. Pierre Mounier-Kuhn. Jour. de méd. de Lyon, **18,** 435–441, Aug. 5, 1937.

Far from being revealed by an abrupt and characteristic clinical picture, the presence of foreign bodies in

the respiratory passages is often unrecognized for a long time. Their frequency is not inconsiderable. The course and the bronchovesicular reactions are variable.

Serious lesions follow the presence of a foreign body in the bronchial tree. The prognosis is guarded, often serious.

In the presence of a pneumopathy of atypical character and development, one must always think of foreign body, and seek for it by roentgenologic and endoscopic exploration.

Five illustrative cases are presented.

S. R. BEATTY, M.D.

HYDATID DISEASE

Hydatid Disease: Clinical, Laboratory and Roentgenographic Observations. M. F. Godfrey. Arch. Int. Med., **60,** 783–804, November, 1937.

Though universally distributed, the highest incidence of hydatid disease is in sheep-raising countries and has increased rapidly in Argentina and Uruguay during the past four decades. The handling of dogs which are fed the viscera of slaughtered sheep and the infection of water supplies are given as principal causes of human infection.

The liver is involved in more than 70 per cent of cases and lung, muscles and cellular tissues, kidney, spleen, orbit, and brain follow in frequency.

Modern roentgenographic and serologic methods used together make diagnosis possible in 90 per cent of cases. The precipitin test is accurate in 65 per cent, the intradermal test in 56 per cent, and the complement fixation test in 52.4 per cent of uncomplicated cases.

The principal roentgenographic sign of hepatic involvement is elevation of the right dome of the diaphragm with disturbance of its normal contour. Perihilar basal markings of the lungs may be found when an infected cyst lies near the upper surface of the liver: 75 per cent of the liver cysts tend to extend downward into the abdominal cavity. The use of a barium sulfate meal or enema, cholecystography, or pyelography is claimed to be of help in demonstrating them. Kidney cysts (2.3 per cent of cases) and splenic cysts (2 per cent of cases) may also be demonstrated in this way.

Pulmonary cysts (12.5 per cent of cases) are most frequently located in the right base and are often flattened against the chest wall or diaphragm. The circular shadow produced is more sharply defined than carcinoma and usually than sarcoma. Abscess, interlobar empyema, actinomycosis, infarct, and intrathoracic struma may produce a similar lung picture, but can be differentiated by clinical and laboratory findings while dermoid cysts contain structures which easily identify them roentgenographically.

In the long bones there is a "punched-out appearance" which may simulate giant-cell tumor, and necrosis of the bone may be present. The absence of actual bony reaction is helpful in diagnosis.

A number of reproductions of roentgenograms are included.

H. A. JARRE, M.D.

INFLAMMATORY DISEASES

The July meeting of the Austrian Roentgen Society was devoted to a detailed discussion of roentgen therapy in inflammatory diseases. Following a review of the subject by W. v. Wieser (*Strahlentherapie,* **62,** 143, 1938), the following papers were presented: The Effect of Radiation on Cell Metabolism, by D. Laszlo and W. Fleischmann, p. 151; The Mechanism of Effect of Roentgen Rays on Inflammatory Processes, by F. Freund, p. 156; The Conservative Treatment of Inflammatory Disease of the Female Genital Organs with Roentgen Rays as a Supplementary Agent, by H. Wintz, p. 159; The Significance of Roentgen Rays Applied in Small Doses in Gynecology, by E. Gajzágó, p. 167; Roentgen Therapy of Paronychia, by O. Spitzenberger, p. 174; Roentgen Therapy of Tonsillitis, by G. Schwarz, p. 181; The Course of Radiation Effect on the Tonsil and its Significance for the Irradiation Therapy of Tonsillitis, by F. Windholz, p. 183; Roentgen Therapy of Acute Inflammatory Peritonsillar Infiltrations, by A. Frank, p. 193; Roentgen Therapy of Exostosis of the Calcaneus, by L. Pokorny, p. 195; Roentgen Therapy of Absolute Glaucoma, by G. Wachner, p. 198; Roentgen Therapy of Neuritis, by H. Hammer, p. 204.

ERNST A. POHLE, M.D., Ph.D.

INFLUENZA

Obstructive Emphysema and Atelectasis in Influenza. William Snow and Charles S. B. Cassasa. Jour. Am. Med. Assn., **109,** 1886–1888, Dec. 4, 1937.

The presence of emphysema of the lungs in influenza was recognized by pathologists for many years, especially during the World War.

X-ray studies of infants' chests impressed them with the belief that obstructive emphysema and atelectasis were of importance in acute respiratory disease. At autopsy emphysema was found anteriorly and the solid parts posteriorly. Most of the solid parts were not pneumonic because they could be inflated by blowing up the communicating bronchi, which proved that they were apelectatic. Since the acutely ill infant is kept lying on the back, secretions in the bronchial tree tend to gravitate posteriorly. This causes complete block followed by atelectasis. Less secretions were present in the bronchi anteriorly but they were sufficient to block the small bronchi only during expiration. As a result, air entered the alveoli and couldn't get out, giving an obstructive emphysema.

Obstructive emphysema in infants as seen on x-ray examination usually involves a good portion of the lobe and causes marked displacements. In an adult the same size bronchus reaches only a small portion of the lung. The larger bronchi are less likely to be involved in this process, so that in studying a film one cannot as a rule expect to find evidence of emphysema by displacements. Instead one may be able to demonstrate small rounded dark zones usually from 1 to 3 cm. in diameter.

Some cases of influenzal bronchopneumonia show extensive confluent bilateral areas of density in the lungs. The picture cannot be differentiated *per se* from acute pulmonary edema or bronchopneumonic tuberculosis. It is difficult to state whether these dense zones are atelectatic or pneumonic or both. The fact that they are often atelectatic can be inferred by the narrowing of the intercostal spaces, displacement of the mediastinum toward the affected side, and elevation of the diaphragm. If the interlobar pleura is thickened, atelectasis will cause the line seen on the film to be curved, with the convexity toward the involvement. Emphysematous zones may be seen contrasted against the non-aerated. These may be mistaken for tuberculous cavities or bronchiectasis.

Any condition causing excessive accumulations in the bronchial tree, whether this is produced by allergy, infection, irritating vapors or various causes of pulmonary edema, is ideal for obstructive emphysema and atelectasis. Influenza is especially prone to produce such a picture.

CHARLES G. SUTHERLAND, M.D.

KELOIDS

The Radium Treatment of Keloids. Tullio Moscariello. Archivio di Radiologia, **13,** No. 4, 317–337, 1937.

After a general discussion of keloids and their treatment, Moscariello reports 29 cases of this lesion treated with radium with satisfactory results in all. He emphasizes that the technic of radium application, both in regard to filtration and time of exposure, must be individualized. He recommends slow and careful treatment.

E. T. LEDDY, M.D.

LEUKEMIA

The Familial Occurrence of Leukemia. P. Gottlebe. München. med. Wchnschr., Jan. 28, 1938, **85,** 140, 141.

The author gives a case report of the development of myeloblastic leukemia in two sisters. In both, the onset of the disease was at the age of 60 (although they were not twins). Examination of three other sisters, and the two daughters of one of the patients, showed no abnormality in four of them; one sister had a leukocytosis due to bronchiectasis.

L. G. JACOBS, M.D.

THE LUNGS

Cancer of the Lung in the Hospitals of Brussels. Marc Herlant. Bruxelles-méd., **17,** 846–860, April 4, 1937.

The incidence of cancer of the lung is increasing in Belgium as in other countries. In this, the second of two papers (*Bruxelles-méd.*, No. 22, p. 800) dealing with the cases of cancer of the lungs seen in the hospitals of Brussels, the anatomical, macroscopic, and microscopic features are presented in detail. Of 103 cases, 83 were men, 19 women, and the average age was in the sixth decade. No one factor could be discovered that might be considered specific, though in a majority of cases some type of chronic irritation of the bronchi was present, infectious or mechanical.

S. R. BEATTY, M.D.

THE NERVOUS SYSTEM

Vegetative Nervous System and Roentgen Rays. R. Glauner. Strahlentherapie, **62,** 1, 1938.

The author first reviews the experimental background of the clinical application of roentgen rays in disturbances of the sympathetic nervous system. This leads him to the conclusion that the effect of irradiation on the nerves is in all probability due to the formation of cholin or of similar substances which change the excitability of the autonomous nervous system. In the clinical section he discusses the use of roentgen rays in the "indirect" treatment of certain conditions by exposing the respective sympathetic nerves. While there is still a discrepancy of opinion as to the quality of radiation (some recommend from 90 to 120 kv. and from 1 to 3 mm. Al, others from 180 to 200 kv. and 0.5 mm. Cu or from 7 to 8 mm. Al), most investigators agree as to the dose: from 100 to 150 r per area, not more than 750 r during a period of two or three weeks. Diseases of the skin, blood vessels, including functional disturbances, disturbances of the motility of the gastro-intestinal tract, inner secretory diseases, epilepsy, and migraine are discussed.

Because this paper offers a good review of our present knowledge in this field and gives ample references to the literature, it is recommended for study in the original (72 pages).

ERNST A. POHLE, M.D., Ph.D.

THE PANCREAS

Pancreatic Cysts. E. Angel. South. Med. and Surg., **100,** 57, February, 1938.

The author gives a partial review of the literature on pancreatic cysts and reports a case in detail. He discusses the condition from the standpoint of classification, etiology, pathology, diagnosis, and treatment. Trauma is the most common etiological factor, occurring in one-third of all cases. The most important symptom is swelling of the abdomen or the appearance of a well defined mass in the upper abdomen. This may be above the stomach, under the stomach or colon, or below the colon where it may be felt in the pelvis and resemble an ovarian cyst. It may fluctuate or transmit pulsation from the aorta. The mass is firm, round, not tender, and usually immobile. A sensation of fullness or weight in the epigastrium is complained of but pain is not a constant or important symptom.

In the case reported by the author, the patient had noticed a mass three months previously. This had continued to increase in size and there was a gradually developing fatigue and slight loss in weight. Of questionable importance from the standpoint of etiology was a history of trauma to the upper abdomen 17 years previously. Roentgen examination showed a large, round, smooth filling defect at the greater curvature of the stomach with the stomach pushed upward into a thin band and with the first part of the duodenum directed upward. The cyst was treated by marsupialization and the patient made a complete recovery. Reproductions of two roentgenograms are included and a bibliography of 25 references is appended.

L. W. PAUL, M.D.

THE PROSTATE

The Use of Radium and Roentgen Irradiation in Benign Hypertrophy and Cancer of the Prostate. Curtis F. Burnam. Am. Jour. Roentgenol. and Rad. Ther., **39**, 75–82, January, 1938.

This is a review of the literature, including the author's own experience. By means of radiation given in a series of treatments, more than 50 per cent of the patients received relief symptomatically, as well as from the standpoint of objective findings (reduction in size of the tumor, relief of residual urine, improvement in functional renal tests). This improvement, from a single series of treatments, may be for only a few years. Some patients respond satisfactorily to very little treatment, others require more. It is well to begin with mild exposures and to avoid temporary swelling. Acutely ill patients, with complete retention, high blood nitrogen and infections, must be hospitalized and treated as if preparation were being made for prostatectomy.

Very intensive treatment, such as is used in cancer cases, has not been reported in the literature. Possibly much better results could be obtained by it than by the mild procedures employed.

The prognosis in carcinoma of the prostate, which heretofore has been bad, now appears more favorable with the present method of radiation, either x-ray or radium. Interstitial implantation and operation should be either preceded or followed by thorough radiation of the pelvis. Obstruction, necessitating catheterization, not promptly relieved by irradiation, should be treated by electrosurgical resection as a preliminary to further irradiation. Metastatic cases should also be treated, since marked palliation, especially relief of pain, can often be secured.

S. M. ATKINS, M.D.

RADIATION EFFECTS

A New Effect of Roentgen Rays. K. Staunig and J. Lobering. Strahlentherapie, **62**, 73, 1938.

Small pieces of various tissues taken from cattle immediately after the killing of the animals were subjected to roentgen irradiation and then, together with untreated controls, submerged in double distilled water for 24 hours. By weighing the specimens before and after this period, the amount of water absorbed could be determined. It appeared that some of the irradiated tissues had absorbed more, some less, water than the untreated controls. This phenomenon was studied in detail on cartilage and led the authors to the assumption that it can be explained by Donnan's theory as applicable to membranes. The practical importance of this hypothesis of "roentgen negative" and "roentgen positive" tissues is briefly discussed.

ERNST A. POHLE, M.D., Ph.D.

RADIUM

Experimental Radium Poisoning. Maurice Rosenthal and Edwin G. Grace. Jour. Med. Soc. New Jersey, **34**, 625, October, 1937.

These authors produced experimental radium poisoning in rabbits by the administration of radium sulfate *per os*. Gingivitis, alopecia, abrasion of teeth, necrosis of bone, spontaneous fractures, regenerative anemia, and hyperplasia and fibrosis of bone marrow were produced. Changes in the blood-forming tissues seem to indicate that in the bone marrow radium poisoning produces at first a stimulation of the cells of the erythroblastic series with a preponderance of normoblasts. Continued action of the radium inhibits maturation of the erythroblasts and there is an extensive replacement of erythroid elements by cells of the granulocytic series, with the production of the picture of so-called "replacement anemia." Changes in lymphoid tissue and calcification of bone were also noted.

W. A. SODEMAN, M.D.

The Use of Radium in Allergic Rhinitis with Polypi. W. G. Scott-Brown. Proc. Royal Soc. Med., **31**, 655–659, April, 1938.

In the past four years the author has treated 47 patients with nasal polypi by radium needle. Best results were obtained in those with a typical allergic history and little or no infection. With severe sinus infection results were not as good and in a few, the infection was aggravated even though the polypi did not recur. Results are more than temporary. Five of the patients were irradiated three and a half years ago with no recurrence, although polypi had been removed many times before. All are not symptom-free now, but none has required further removal of polypi.

W. A. SODEMAN, M.D.

Radium Molds Made of Wax and of Dental Molding Compound. W. Luther. Strahlentherapie, **62**, 116, 1938.

The disadvantages of the use of beeswax in preparing radium molds are discussed. The author then outlines

his technic of preparing molds by means of the compound used by dentists. The latter material is much more suitable for this purpose.

ERNST A. POHLE, M.D., Ph.D.

THE RIBS

Cervical Rib and Scalenus Anticus Syndrome. Editorial. Jour. Am. Med. Assn., **109,** 877, Sept. 11, 1937.

Because the vertebral column in the embryo grows faster than the spinal cord, the nerves and plexuses issuing from the latter must assume an oblique course in order to reach the extremities. They thus interfere with the growth of the ribs. Consequently the ribs in the new-born come to be represented in the cervical region by the transverse processes of the vertebral bodies. The supernumerary cervical rib may, therefore, be regarded as a developmental anomaly. It springs as a rule from the seventh cervical vertebra but may occasionally arise from the sixth or fifth. The rib may extend just beyond the transverse process of the vertebra or even touch the first rib; it may reach the cartilage of the first thoracic rib as a fibrous band or even as true cartilage. If the rib attains sufficient length, the brachial plexus and the subclavian artery may be compressed in the angle formed by the rib and the scalenus anticus muscle, giving rise to nervous and circulatory disturbances. The incidence of cervical ribs is variably given as between 0.03 and 0.1 per cent. When they are present, from 67 to 80 per cent are bilateral. Two supernumerary ribs on the same side have been reported only three times.

A contribution to both the genesis of the symptoms and their surgical relief was made by Adson and Coffey when they found that severance of the scalenus anticus muscle from its insertion into the rib caused immediate relief of pressure and irritation from the brachial plexus and the subclavian artery.

Carrol reported two cases of cervical rib syndrome without cervical ribs and obtained complete relief of symptoms in one case by operation of scalenotomy. Others have had similar experiences. Compression may be due to abnormally low position of the shoulder, to high fixation of the sternum and ribs, to low origin of the brachial plexus, and to elevation of the first thoracic rib due to spasm of the scalenus muscles, resulting from brachial plexus irritation.

CHARLES G. SUTHERLAND, M.D.

RICKETS

The Significance of Early Childhood Rachitic Bone Changes in Later Life. Max Lange. München. med. Wchnschr., **84,** 2022–2028, Dec. 17, 1937.

The bony changes due to rickets are discussed, especially the deformities which may occur in the spine and limbs. The scoliosis which may result is treated by various exercises, the limb deformities by orthopedic measures and exercises. The dangers of gymnastics in clinical and subclinical rickets is emphasized. The marked tendency for young children to show anatomical recovery from the deformities is noted. The prevention and early treatment of the disease should be emphasized.

L. G. JACOBS, M.D.

SILICOSIS

A Study of the Crystalline Siliceous Minerals Present in Silicotic Lungs by the X-ray Diffraction Method. C. M. Jephcott, W. M. Gray, and Dudley A. Irwin. Canadian Med. Assn. Jour., **38,** 209–215, March, 1938.

The authors have studied by the x-ray diffraction method the siliceous fraction of 35 lung ashes of persons exposed to various types of siliceous dusts. The lung ashes were treated with acids to remove all the acid-soluble material and a fraction was obtained which consisted practically entirely of silica and silicates. This procedure greatly increases the intensity of the bands in the x-ray diffraction patterns and no changes in patterns were found as the result of such treatment.

This method of assay possesses distinct advantages. Only small amounts of material are necessary and crystals may be identified, if only a fraction of a micron in size. However, the method cannot be used for amorphous material, nor to differentiate between crystalline substances having the same internal molecular structure.

No definite correlation has been found between the x-ray diffraction patterns and the occupational histories. A partial explanation of these differences may be that differences in dust exposure exist in the same mine or industry, and they depend upon the type of work done by the individual. Also the presence of tuberculosis in the lung does not appear to produce any detectable modification in the relative proportions of the different siliceous minerals present. No correlation seems to exist between the patterns and the age, the length of the interval between last exposure and termination of the case, or total silica content of the lungs.

W. A. SODEMAN, M.D.

SKIN DISEASES

Chronic Actinic Dermatitis: An Occupational Hazard of the Southwest. Leslie M. Smith. Texas St. Jour. Med., **33,** 644–647, January, 1938.

Chronic actinic dermatitis is an acceleration of a normal aging process due to the ultra-violet rays of the sun acting upon a susceptible skin. In the Southwest where there is little cloud to filter the abundant sunshine it is particularly common in red-haired and freckle-faced individuals, in the presence of seborrhea, and in farmers, ranchers, and others exposed to the sun.

The skin changes are quite similar to those seen in chronic radiodermatitis. Clinically, pigmentation, depigmentation, atrophy, telangiectasia, and what is more significant, keratoses and squamous-cell epitheliomas may be present. The author refers to cases occurring in individuals as young as from 16 to 20 years

of age, and advanced changes seen in the early thirties. Prophylactic measures in the use of hats, gloves, and non-irritating creams or oils are of value in preventing or arresting these changes. Curettage, caustics, and electrodesiccation are recommended for early superficial keratoses. For more advanced lesions electrocoagulation is preferable. Caution is urged in the use of x-rays and radium since the skin changes are similar to those of a radiodermatitis.

JOHN M. MILES, M.D.

The Radiosensitivity of Benign Skin Conditions. C. M. Henry. Canadian Med. Assn. Jour., **38,** 371, 372, April, 1938.

Henry described the radiotherapy for a number of the benign skin conditions encountered in everyday practice. He included verruca, clavus, senile keratosis, painful keloids, nevi, pruritus vulvæ and ani, eczema, acne vulgaris, furunculosis, hyperhidrosis, infectious diseases (mycosis fungoides, ringworm of scalp, and sycosis), impetigo, erysipelas, blepharitis, eczema of the lids, papillomas, and keratosis in his discussion. The roentgen therapy is briefly described. Prognosis and limitations of therapy are mentioned for most of the above diseases.

GEORGE E. BURCH, M.D.

Roentgen and Ultra-violet Radiation in Dermatology: Uses and Limitations. D. E. H. Cleveland. Canadian Med. Assn. Jour., **37,** 558–563, December, 1937.

The author briefly discussed the use of roentgen and ultra-violet irradiation in dermatologic conditions, citing in each instance the value of each form of therapy. Cleveland, in his concluding remark, quotes Harrison, who stated that, "To the specialist in any branch of medicine, the limitations and the extent of the assistance which can be obtained from roentgenology is well known with regard to his own field of work, but the general practitioner as a rule is not usually quite so well informed regarding the positive and negative aspects of this method of investigation and treatment."

GEORGE E. BURCH, M.D.

THE SKULL

The Difficulties of Interpretation of Skull Roentgenograms in the Otorhinologic Field. Hch. Unger. Schweiz. med. Wchnschr., Jan. 29, 1938, **68,** 110, 111.

A semi-editorial article briefly recounting the pitfalls which lead to mis-diagnoses in the skull. The article is rather too brief for clarity.

L. G. JACOBS, M.D.

Five Cases of Fracture of the Middle and Posterior Portions of the Base of the Skull. Lachapele. Bull. et mém. Soc. de Radiol. Méd. de France, **25,** 776, 777, November, 1937.

In cases of trauma to the cranium, fractures of the base are frequently missed because of inadequate examination. A complete study of the skull requires not only postero-anterior and lateral films but also films taken in the fronto-suboccipital projection and the vertical projection. Often, in addition, films in the Schüller, Stenvers, and Mayer projections are required.

Five cases illustrating the value of a complete examination are presented.

S. R. BEATTY, M.D.

THE SPINE

Discogenetic Disease of the Cervical Spine, with Segmental Neuritis. Albert Oppenheimer and Edward L. Turner. Am. Jour. Roentgenol. and Rad. Ther., **37,** 484–493, April, 1937.

Primary thinning of the intervertebral disks seems more common in the cervical spine than in any other segment. In the writers' experience this is invariably associated with pain in one or both upper extremities, between the shoulder blades, or in the precordium, and often with weakness of certain muscle groups, and at times with muscular atrophy. Neck symptoms, however, are rare, only two patients in the authors' series having complained of pain in the neck or of stiffness. In the majority of the cases clinical symptoms had persisted for several years or longer, and there were secondary exostosis changes on the vertebral body margins but with only one exception there were no changes in the true intervertebral joints. The most significant change, however, was in the nature of the narrowing of the intervertebral foramina which may be unilateral or bilateral. This narrowing is demonstrated best by oblique views of the cervical region. The lesion, which usually begins after the age of 30, is not systemic but is mostly limited to the cervical spine. The writers suggest the term "discogenetic disease" for the pathologic and clinical entity.

J. E. HABBE, M.D.

A Case of Congenital Fusion: Four Lumbar Vertebræ: Supernumerary Hemivertebra Adjacent. Chérigié and Roederer. Bull. et mém. Soc. de Radiol. Méd. de France, **25,** 782, 783, December, 1937.

A case of fusion of the first to fourth lumbar vertebræ with the additional findings of a hemivertebra and supplementary rib.

S. R. BEATTY, M.D.

THE STOMACH

Antral Gastritis and Spasm. Ross Golden. Jour. Am. Med. Assn., **109,** 1497–1500, Nov. 6, 1937.

Gastritis is an inflammation of the gastric wall of as yet unknown etiology, which begins in, and may be limited to, the mucosa but which frequently extends to the deeper layers, even to the serosa. The disease may be generalized throughout the entire stomach but it is often limited to, or has its maximum effect in, the antrum. Inflammatory changes in the antrum may pro-

duce serious disturbances in gastric function. The term "antral gastritis" has been coined and it is synonymous with the terms "pyloritis" and "pyloric gastritis."

The diagnosis of gastritis depends mainly on the gastroscopic and on the x-ray examination.

Antral gastritis is associated with a "prepyloric syndrome." This syndrome consists of (1) prepyloric narrowing of varying degrees due to spasm; (2) abnormal, stiff, irregular peristalsis; (3) sometimes exaggeration and sometimes diminution or absence of mucosal folds; (4) hypertrophy of the pyloric muscle; (5) shallow mucosal erosions which are not demonstrable by x-ray methods, or penetrating ulcer of the lesser curvature; (6) delay in emptying sometimes resulting in a twenty-four-hour gastric residue. These signs may not all be present in one case.

CHARLES G. SUTHERLAND, M.D.

Diverticula of the Stomach. Pierre Hillemand, J. Garcia-Calderon, and Artisson. Arch. d. mal. de l'app. digestif, November, 1937, **27**, 919–958.

The diagnosis, pathological anatomy, and etiology of diverticulum of the stomach are discussed in detail. The authors consider etiology at some length and are inclined to believe that the diverticula of the fundus of the stomach are congenital in origin. Those of the pyloric region are probably associated with pancreatic islands in the gastric walls. Studies of certain animals show the "anlage" of the diverticulum of the fundus to be a normal feature of these animals. An extensive bibliography of the subject is included.

S. R. BEATTY, M.D.

The Radiologic Diagnosis of Ulcer of the Posterior Wall of the Stomach. A. Rosselet. Schweiz. med. Wchnschr., March 5, 1938, **68**, 243–245.

The author advocates the examination of the partially filled stomach in dorsal decubitus in cases in which the air bubble and the change in position of the gastric walls often render easier the diagnosis of ulcer of the posterior wall, particularly in the upper third of the stomach.

L. G. JACOBS, M.D.

THE THYMUS

Sudden Death in Infancy. Alton Goldbloom and F. W. Wiglesworth. Canadian Med. Assn. Jour., **38**, 119–129, February, 1938.

The authors studied 30 infants who died suddenly. They were convinced that the "ordinary thymus could not possibly compress the trachea. Only in rare instances, when there are processes going up into the episternal notch, does the thymus come into any relationship to the trachea at all." In a study of the literature, the authors were impressed with the lack of evidence that the thymus *per se* had any direct relationship to the cause of sudden death in infants.

An analysis of 30 cases of sudden death in infancy revealed interesting findings. Nineteen at autopsy showed definite inflammatory lesions, indicating, it is believed, a fulminating bacterial infection; four were asphyxiated from a mechanical cause; three from the aspiration of milk, and one from a large hemangioma of the trachea. The remaining case was of theoretical importance, because, in addition to a healing pneumonia, the child had a most remarkable localized hypertrophy of the islands of Langerhans.

Five of the remaining six patients showed indefinite inflammatory lesions, but taking into consideration the clinical and pathologic findings, which were all similar, it is possible that they died of a fulminating infection. They were characterized by a vague preceding history, sudden death, and at postmortem by interstitial pneumonia, petechial hemorrhages in the lungs, thymus, and pericardium, and sometimes by a septic type of spleen. The sixth patient probably died of laryngeal spasm associated with tetany. The thymuses, with two exceptions, were not sufficiently enlarged to be abnormal. One of these children died from the aspiration of milk, while the other showed evidence of a generalized infection.

It has been shown that the weight of the thymus in the sudden death group of apparently well children is the same as in the group which died in 24 hours from the onset of definite clinical signs of infection. None of the classical features of the status lymphaticus syndrome were present. Further, sudden death has frequently occurred in cases in which the thymus was small.

It is suggested that many cases of sudden death, although not all, are caused by fulminating infections, possibly associated with immature immunity on the part of the infant. The lesions commonly found are an interstitial pneumonia and a peribronchitis. Lastly, it is urged that postmortem examinations in cases of sudden death be very thorough, from both the bacteriologic and pathologic viewpoints, before yielding to the temptation of making the easy diagnosis of status thymicolymphaticus. When no pathologic lesions can be found, the pathologist must look to the biochemist or endocrinologist for help.

GEORGE E. BURCH, M.D.

THE TONSILS

The Radiation Treatment of Hypertrophied Lymphoid Tissue of the Pharynx and Nasopharynx. Robert J. Reeves. Am. Jour. Roentgenol. and Rad. Ther., **37**, 510–512, April, 1937.

Surgical treatment is believed indicated in cases in which there is obvious infection of tonsils, but if there is simple tonsillar hypertrophy, radiation therapy may produce very satisfactory clinical results.

However, when non-encapsulated lymphoid tissue is present in the pharynx and nasal pharnyx which cannot be removed surgically due to the wide scattering of the lesions over the posterior and lateral walls of the pharynx, radiation treatment is regularly the method of election.

Over a period of six years the writer has treated approximately 300 patients, of which number 189 completed the treatment. In this group all but two had had tonsils and adenoids previously removed. The technic and dosage is as follows: 100 kv. constant potential, 25 cm. distance, 3 mm. aluminum filter, dosage 100 r administered to either side of the neck at weekly intervals, with four to six treatments in a series. At times a third field is also used over the bridge of the nose, this being a 4 cm. area. There may be some transient immediate reaction in the nature of congestion or swelling of the cervical nodes immediately following the treatments, but gradually the follicles lose their granular appearance and are replaced by fibrous tissue. This method of treatment regularly gives satisfactory results after all other methods have failed.

J. E. HABBE, M.D.

TUMORS (DIAGNOSIS)

Rhabdomyosarcoma of the Testicle. M. Gerundo and W. W. Corwin. Jour. Kansas Med. Soc., **39,** 95–98, March, 1938.

A case of this rare tumor occurring in a male 70 years of age is reported by the authors. The patient had a large tumor of the left testicle for many years. Eventually this became so large that he was no longer ambulatory. The tumor was removed but the patient died about a year later with evidence of metastasis.

The postmortem findings are given together with a detailed discussion of the pathological features of the tumor and its metastases.

L. W. PAUL, M.D.

A Case of Retroperitoneal Cyst, with a Clinical Study of the Subject. Mahmoud Hafezi. British Jour. Surg., **25,** 267–276, October, 1937.

The author describes a retroperitoneal tumor, or what is sometimes vaguely called "mesenteric tumor," the postmortem curiosity of the sixteenth to the eighteenth centuries, and the surgical puzzle of the nineteenth century. This has ceased to be a rarity, for about five hundred cases have been reported, but it still remains somewhat of a problem to the diagnostician in spite of the advanced auxiliary methods of diagnosis now available, while its surgical treatment often presents serious considerations. This perhaps is due to the diversity of its situation, the complexity of its origin, and its still comparative infrequency, so that no one surgeon is likely to encounter more than a very few cases.

The description of the case of retroperitoneal cyst with rather unusual features included its pathology and treatment. A short survey of the clinical, diagnostic, therapeutic, and prognostic features of the problem was presented. The author concluded that every case must be judged on its own merits, since the factors affecting this problem are numerous. Quite a number of the cysts show some sign of malignancy. Other points in the prognosis are the size, location, and attachments of the cyst, the duration of its existence, the time of the operation, etc.

DAVIS H. PARDOLL, M.D.

The Correlation of Roentgenological Findings with the Pathology of Bone Tumors. Jesse B. Johnson and W. J. Stork. Texas St. Jour. Med., **33,** 741–743, March, 1938.

The authors discuss the differential diagnosis of bone tumors. In case of any doubt as to the nature of a bone lesion, it is classified as strongly suspicious of malignancy.

JOHN M. MILES, M.D.

A Case of Benign Tumor of the Stomach. Albert Poirier. Bull. et mém. Soc. de Radiol. Méd. de France, **25,** 768–771, November, 1937.

A case of benign adenoma of the stomach demonstrated radiologically is presented and the diagnosis discussed.

S. R. BEATTY, M.D.